THE NIGERIAN RICE ECONOMY IN A COMPETITIVE WORLD:
CONSTRAINTS, OPPORTUNITIES AND STRATEGIC CHOICES

Rice production systems in Nigeria: A survey

By

Olaf Erenstein, Frederic Lançon, S.O. Akande, S.O. Titilola, G. Akpokodje and O.O. Ogundele[1]

September 2003

West Africa Rice Development Association (WARDA)[2]
Abidjan, Côte d'Ivoire

[1] The first two authors are respectively economist, WARDA-Bamako & economist, CIRAD-Montpellier (former WARDA economist). Subsequent authors are economists of NISER-Ibadan

[2] The study is part of a USAID-funded project and jointly implemented by WARDA and NISER. The views expressed in this report are those of individual scientists and do not necessarily reflect the views of USAID, WARDA or NISER.

Acknowledgement
The present study was jointly implemented by WARDA and NISER within the context of the USAID-funded project "The Nigerian Rice Economy In A Competitive World: Constraints, Opportunities And Strategic Choices".

The implementation of the survey benefited from the assistance of Yussuf Rotimi Rabiu, Zakariyah Olayiwola Amoo, Gbadebo Odularu, Michael Tiletswen, and Nuhu Sadiq Bullow as the five survey supervisors recruited specifically for the survey. The implementation was made possible by the assistance provided by the Agricultural Development Programs (ADPs) in Niger, Kaduna, Ekiti, Benue and Taraba state and their willingness to make available as enumerators Abdullahi Mohamm, Abubakar N. Sani, Adebiyi B. S., Dada J. O., Daniel Laah, Fidelis Patrick, Friday Joshua Ub, Isah Y.Z., John Angwe, Mathew Monshari, Mohammed Abubaka, Simon Ater, and Tanimu Dauda.

The views expressed in this report are those of individual scientists and do not necessarily reflect the views of USAID, WARDA or NISER.

Table of contents

1 Introduction

The Nigerian rice sector has seen some remarkable developments over the last quarter-century. Both rice production and consumption in Nigeria have vastly increased during the aforementioned period. Notwithstanding, the production increase was insufficient to match the consumption increase - with rice imports making up the shortfall. With rice now being a structural component of the Nigerian diet and rice imports making up an important share of Nigerian agricultural imports, there is considerable political interest in increasing local rice production. This has made rice a highly political commodity in Nigeria. However, past policies have not been successful in securing the market share for local rice producers. There is a need to draw lessons from these past policies – particularly by finding out was is really happening on the ground in terms of rice production and processing. This is the more urgent in view of the recent resurgence of an active interest to develop the rice sector in Nigeria.[1]

The Nigerian rice sector is special within the West African context. First, as rice is primarily a cash crop in Nigeria – i.e. it is produced primarily for the market as will be shown in this report. This reflects the combined effect of Nigeria - as a country - being a relatively non-traditional rice producer/consumer[2] with a rapid recent increase - and still increasing – demand for rice. Second, as rice is primarily consumed in its parboiled form. Parboiling adds value to rice in the production and consumption chain, but together with the prevalent milling practices also has major implications for the quality of Nigerian rice (particularly vis-à-vis imported rice). Third, the sheer relative size of the current rice sector in Nigeria with respect to West Africa as a whole – both in terms of rice production and consumption.

Despite the importance of Nigerian rice production within the West African context, a comprehensive and up to date picture of the rice sector in general and rice production and processing in particular was lacking (Akpokodje et al., 2001). The present study tries to address this information gap through a rice producers survey. The survey aims to answer questions in relation to:

- *Rice producers:* What are the main characteristics of rice producing households (e.g. in terms of their resource base, economic activities and scale)? What is the position of rice in the farming system? What is driving producers to cultivate rice?
- *Rice production:* What are the current crop management practices for rice (varieties, fertilizer use, mechanization…)? What are the rice yields? How are these factors determined by ecology? Which major technological changes have occurred? Is there a gender division of labor? What are the production problems farmers are actually facing in the field? What are the main current rice production systems?
- *Rice utilization, processing and marketing:* What share of rice produced is marketed and consumed? What processing and marketing channels are used? What are the marketing problems farmers are actually facing?
- *Competitiveness of rice production:* What are the rice production costs? What factors determine producer efficiency? Can Nigerian rice producers compete with imported rice?

The specific objectives of the present study are:

1. to characterize rice production in Nigeria in terms of producers, production and utilization practices;
2. to analyze the competitiveness of Nigerian rice production systems;
3. to provide the basis for the development of a strategy to revitalize the Nigerian rice sector.

[1] E.g. Presidential advisory committee for rice; Central Bank of Nigeria national seminar 'Sustainable rice production in Nigeria', January 2003; The foodbasket magazine, Special edition on rice, January 2003.

[2] There are traditional rice producers/consumers in Nigeria (e.g. certain ethnic groups in Niger state). However, within Nigeria as a whole rice is not a traditional crop/food.

The present rice producer survey is a component of a larger effort to update knowledge on current conditions under which rice is produced and processed in Nigeria. Complementary reports address rice processing (Lançon et al, 2003a), rice consumption (Lançon et al, 2003b) and irrigated rice (Kebbeh et al, 2003). The study and the larger project it contributes to have benefited from financial support from USAID.

The present study consists of seven sections – the first section being this introduction. Section two introduces the methodology. Section three subsequently characterizes rice producers, section four rice production and section five rice utilization, processing and marketing. Section six reviews the economics of rice production. Section seven concludes.

2 Methodology

Primary data were collected from 42 villages and 252 rice farmers during the spring of 2002. To collect the data the study used a stratified sampling frame. Four levels of stratification were used: the state, the local government area (LGA), the village and the rice farmer level. At the final level, random sampling was used. The choice at the first three levels was purposive and reasoned. Due to logistic and budgetary limitations the study was limited to 5 states, with 2-3 LGAs per state, 3 villages per LGA and 6 rice farmers per village.

The selection of the 5 states has been done on the basis of (i) the share of each state in national rice cropped area, (ii) the share of rice in the state's food cropped area and (iii) the type of dominant rice ecologies. The 5 states retained were Kaduna, Niger, Taraba, Benue and Ekiti. The selection of the 2-3 LGAs within each state was done on the basis of (i) being important rice producing areas according to the state extension agents; (ii) geographic spread within the state while remaining within a days travel of each other; and (iii) the type of dominant rice ecologies. Three LGAs were chosen per state, with the exception of Ekiti state were only 2 LGAs were chosen as this is a relatively small state with one dominant rice ecology (upland rice). The choice of the 3 villages within each LGA was done along similar criteria as the LGA selection. The choice of the 6 rice farmers within each village was random. Figure 1 presents the sites were the study was implemented (see Annex 1 for details).

The used sampling frame has some important implications for the interpretation of the results. First and foremost it has to be reiterated that the results are from a survey of current rice farmers. We have thereby purposively omitted farmers that have never cultivated rice but also those farmers that may have stopped producing rice. Furthermore, the used stratified sampling frame also implies that we tend to have selected areas were rice production is relatively established and widespread. This in turn may imply a bias of these rice farmers vis-à-vis rice farmers in areas where rice production is less established and widespread – for instance in terms of suitability of the bio-physical resource base for rice production or the access to rice processing and marketing facilities.

The producer survey comprised two questionnaires: (i) a producer questionnaire; and (ii) a village questionnaire (Annex 4). The 10-page producer questionnaire was administered to 252 individual rice producers. The producer questionnaire collected information at two levels: for the farm household as a whole and for a selected rice field to compile rice production input output data and cultivation practices. The household head was typically the main informant (97% of cases). The 4-page village questionnaire was administered in each of the 42 selected villages to a group of selected informants – typically including the village head and others knowledgeable of rice production within the village.

The present report primarily presents information derived from these two surveys. That is, the two surveys are the source of all quantitative data in the text and tables – unless specifically indicated otherwise. Data presented in terms of 'at the village level' or 'share of villages' are typically derived

from the village survey, whereas 'at the farm level' or 'share of households' are typically derived from the farm survey.

Survey data imply that we rely on farmer responses and enumerators to capture these. We have used several cross-checks to enhance the reliability of the dataset and discard unreliable data. Still, even after such cleaning, some unverifiable data errors are bound to remain. For instance, numerous units and measures are used in rice production in Nigeria, and some of these differ between and even within the surveyed states. The conversion to metric units was therefore not always straightforward, thereby increasing potential measurement error. To acknowledge the survey origin and possible underlying errors, data are generally presented to the second significant figure only.

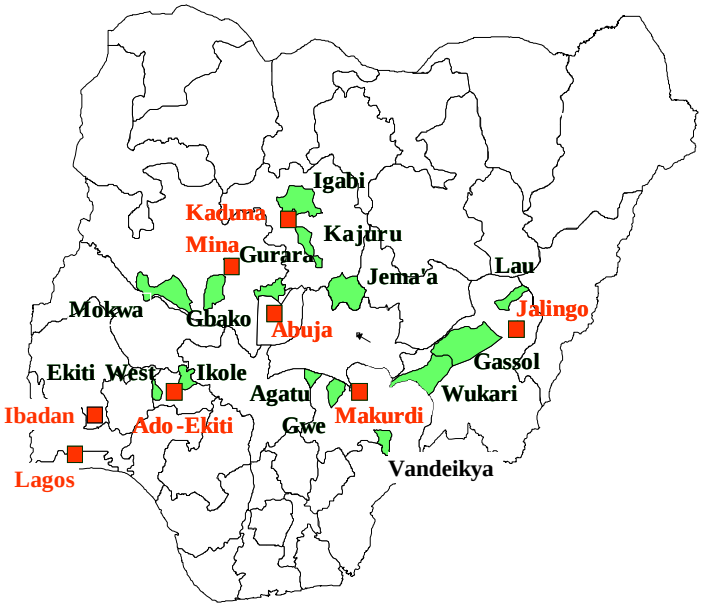

Figure 1 Location of survey sites

(shaded are the surveyed LGAs. Squares represent state capitals: Mina, Niger State; Kaduna, Kaduna State; Ado-Ekiti, Ekiti State; Makurdi, Benue State; and Jalingo, Taraba State)

3 Characteristics of rice producers

The present chapter characterizes rice producers so as to answer a number of questions. For instance, what are the main characteristics of rice producing households (e.g. in terms of their resource base, economic activities and scale)? What is the position of rice in the farming system? What is driving producers to cultivate rice? The chapter first presents selected characteristics of the rice production enterprise. It subsequently characterizes rice producers - first based on their resource base and subsequently on their economic activities. The subsequent section reviews some of the dynamics of the rice enterprise. The final section derives a typology of rice producers through cluster analysis – followed by a brief discussion/summary.

3.1 Selected characteristics of rice production enterprise

At first glance the rice producing villages - and households - do not have easily distinguishable socio-economic features that distinguish them from non-rice producers. Rice production however does seem to be concentrated in selected geographic areas in Nigeria. In part this is related to bio-physical aspects – for instance the prevalence of rice production in Nigeria's Middle Belt and in lowlands and on the floodplains adjacent to the Niger and Benue rivers. However, another major factor driving concentration of rice production in geographically defined areas is the rice processing and marketing chain. First, as rice in Nigeria is primarily produced for the market. Second, as the produced paddy needs to be processed into parboiled rice. Third, as transaction costs for paddy marketing are substantially reduced by geographic concentration. These factors are likely to disadvantage potential individual rice producers in non-established rice producing areas.

Within the rice producing villages, rice production is widely established. On average, 83% of the village households are engaged in rice production – an indicator which is relatively constant across the five states, ranging from 77% in Kaduna and Benue to 91% in Niger state (Table 1). The prevalence of rice-growing within the villages also implies that there are limited distinguishable social features. Only in Ekiti state were rice farmers seen to be typically Yoruba and often men. In Kaduna and Niger state rice producers also tended to be male – although this is also likely to apply to the production of other major crops in these sharia-states.

Table 1 Prevalence of rice production at the village level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Share of village households producing rice (average, n=41)	91% b	77% a	84% ab	88% ab	77% a	83% (.08)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The three main rice ecologies in West Africa are: (i) Rainfed upland; (ii) Rainfed lowland – i.e. without water control; and (iii) Irrigated – i.e. lowland with water control. Rice production in Nigeria is predominantly rainfed, with an emphasis on lowlands (Singh et al., 1997). The survey results are in line with these earlier results (Table 2). Only 6% of the surveyed rice producers reported having irrigated rice – concentrated in the Niger state.[3] Rainfed upland rice – hereafter referred to as 'upland rice' - was reported by 37% of the surveyed farmers, with a marked emphasis in Ekiti state. Rainfed lowlands - hereafter referred to as 'lowland' - are the predominant ecology overall, reported by 70% of the surveyed farmers - with a clear emphasis in Niger, Taraba and Benue states. Kaduna state presents the most balanced division between the upland and lowland ecology. Table 2 also illustrates

[3] Irrigated rice in Nigeria was subjected to a complementary study within the context of the overall project so as to better understand the prospects of developing irrigated rice – see Kebbeh et al, 2003.

that rice farmers tend to grow rice in one of the main rice ecologies only.[4] Only 13% of the surveyed farmers reported growing rice in two of the three main ecologies.

Table 2 Rice ecologies reported at farm level in survey states (share of households within column reporting across all rice fields, multiple response)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Upland	0%	56%	97%	24%	30%	37%
Lowland (without water management)	95%	54%	3%	91%	85%	70%
Irrigated (lowland with water management)	30%	0%	0%	0%	0%	6%

Multiple response implies that the same household can pertain to various categories at the time. Consequently, % do not necessarily add up to 100% within each column.

Rice is predominantly produced by small-holders. On average, rice producing households produce 4.6 tons of paddy per year from an annual crop area of 3.3 ha. This corresponds with an overall average yield of 1.8 tons of paddy per ha (Table 3). These averages however mask significant differences amongst the various surveyed states. Rice production per household is highest in Taraba and Niger state – averaging respectively 8 and 6 tons of paddy per year. However, in the case of Taraba, this is the result of substantial crop areas (on average 8 ha), whereas aggregate rice yields are low (on average 1 ton of paddy). In contrast, Niger state has the highest average yield (on average 3 tons of paddy) from a relatively limited area (on average less than 2 ha). The higher yields in Niger state are partly related to the contribution of irrigated rice.

Table 3 Selected rice production characteristics at farm level in survey states (average per household)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Total rice production (MT paddy per household)	5.8 b	3.5 a	2.9 a	8.0 c	2.5 a	4.6 (.00)
Total rice area (ha per household)	1.8 ab	2.5 b	1.3 a	7.7 c	2.6 b	3.3 (.00)
Average rice yield for farm (MT paddy/ha)	3.1 d	1.6 b	2.3 c	1.1 a	1.1 a	1.8 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

3.2 Resource base of rice producers

3.2.1 Household composition and labor

Rice producing households are predominantly male-headed, with 1.2% female-headed. The average age of the household head is 47 years (±12). The household head typically is able to read (70%). Of those that reportedly can read, 58% can read English, 32% Arabic and 10% their ethnic language. Reading skills are closely related to the schooling level of the household head:

- No schooling: 29%
- Koranic schooling: 20%
- Basic schooling (Pre-primary; adult education; primary): 23%
- (pre-)Secondary schooling: 22%
- Tertiary or higher schooling: 6%

[4] The % in excess of 100% when summing up the column reflects the incidence of cultivating in more than one ecology.

Various ethnic groups are engaged in rice production, and these vary over each of the surveyed states. On aggregate, 27 ethnic groups were reported across the five surveyed states, with as most frequently reported tribes Tiv (14%), Nupe (14%) and Hausa (14%). Rice producers are typically native of the region (90%).

The average household is made up of 13.5 individuals – being almost equally split between males and females, and comprising about one-third adults and two-thirds children (Table 4). In terms of their economic contribution to the household, the average household comprises:

- 5.1 individuals working primarily on-farm;
- 2.0 individuals working primarily off-farm;
- 6.5 dependants (school going children, non-working members).

Table 4 Household composition of survey farmers (average # of persons)

Age \ Sex	Male	Female	Total
Adult	2.0	2.4	4.4
Child	5.1	4.1	9.1
Total	7.1	6.5	13.5

Family labor can be supplemented with various other forms of labor. In all surveyed villages hired labor was available. Labor exchange (i.e. non-monetized, in-kind exchange) is relatively common (reported in 88% of 32 villages). Less frequently reported options of additional labor include communal labor (22% of 32 villages) and by invitation (3% of 32 villages).

Nearly all (98%) rice producing households supplement their family labor with non-family labor. Most common is the use of hired labor (91%), and to a much lesser degree labor exchange (23%). The clear emphasis on hired labor is likely related to the market orientation of the rice production. At the same time, 34% of rice producing households reported having household members working as hired labor elsewhere. Hiring-out of labor can be seen as an indicator of limited household resources, thereby reiterating that rice production is relatively small-scale.

3.2.2 Land

Rice producing households are typically smallholders, on average cultivating 8 ha of land per year.[5] There is a significant variation of land area over the various surveyed states. On the lower end, is Ekiti state with only 3 ha. On the high end is Taraba state with nearly 15 ha, with the other states having intermediate areas of 6-7 ha (Table 5 – first layer).

The households typically own or have usufructury rights over the cropped land. Only a fraction of the land area is reportedly sharecropped or rented in (Table 5 – second layer). The household head typically is the plot manager for most cropped land.

The average farm area comprises 5 ha of upland and 3 ha of lowland, with only 0.1 ha of irrigated lowland. There are some marked differences between the states (Table 5 – last layer). First, the land area tends to be divided amongst upland and lowland in most states – only in Ekiti state is the lowland area relatively insignificant. Second, upland tends to be the prevalent land type in each state. Only in Taraba state, is the lowland area slightly more than half of the cropped area. Finally, the irrigated land type was only significant in Niger state.

[5] The land is typically single-cropped. As a result, annual cropped area typically corresponds with the physical area being used for cropping. Annual cropped area is used here as proxy for farm size, but excludes fallow area which proved problematic to estimate.

Table 5 Average size of land holding at household level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Total annual cropped area by household (ha/hh)	6.4 b	7.1 b	2.9 a	14.6 c	6.2 b	7.8 (.00)
Annual area by land tenure (ha/hh)						
- Usufruct/Owned	5.4 b	7.0 b	2.1 a	12.8 c	5.8 b	7.0 (.00)
- Share cropped	0.0 a	0.0 a	0.4 b	0.5 b	0.0 a	0.2 (.05)
- Rented in	0.6 b	0.1 a	0.3 a	1.1 b	0.1 a	0.5 (.01)
- Unspecified	0.4	0.0	0.0	0.1	0.0	0.1 (.21)
Annual area by ecology (ha/hh)						
- Upland	4.5 bc	5.5 c	2.8 a	7.2 d	3.7 ab	4.9 (.00)
- Rainfed lowland	1.5 b	1.6 b	0.1 a	7.4 c	2.2 b	2.8 (.00)
- Irrigated lowland	0.4 b	0.0 a	0.0 a	0.0 a	0.0 a	0.1 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

3.2.3 Capital

The surveyed rice producing households typically have a limited capital base. For instance, 83% of the households owned no significant agricultural equipment (i.e. other than agricultural tools as hoes, etc), whereas 14% own one piece of equipment and 4% two or more pieces. Application equipment (backpack sprayers) is the most common type of equipment reported (12% of households). Other less common types of equipment reported include processing equipment and land preparation equipment (Table 6).

Table 6 Ownership of agricultural equipment at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Any agricultural equipment	17%	17%	14%	24%	11%	17% (.47)
- Application equipment	17%	13%	6%	13%	11%	12% (.63)
- Processing equipment	0%	7%	6%	11%	0%	5%
- Land preparation eq.	0%	2%	3%	11%	0%	3%
- Water pump	0%	2%	0%	2%	0%	1%

About half the households reported using other people's agricultural equipment to supplement their limited equipment base (Table 7). Application equipment was again the most common type of non-owned equipment used (30% of all households) – mainly for herbicide application and most common in Benue and Niger state. Use of non-owned tractors was second, with a quarter reporting their use – mainly for harrowing & plowing. Tractor hire is particularly widespread in Taraba state – in part a reflection of the substantially larger areas cropped.

Table 7 Use of other people's agricultural equipment at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Any agricultural equipment	48%	32%	36%	83%	63%	54% (.00)
- Application equipment	41%	9%	33%	15%	54%	30%
- Tractor	7%	22%	3%	70%	11%	24%
- Oxen plus equipment	0%	0%	0%	2%	0%	0%

About three-quarters of the households have some means of transport – most commonly a bicycle (56%) or a motorcycle (33% - Table 8 – first layer). A quarter of the households reported having a TV (Table 8 – second layer). Although both can be potentially seen as indicators of wealth and capital base, there are some marked differences between the two over the surveyed states.

Particularly the case of Ekiti state vis-à-vis the other states is noteworthy. In Ekiti state, households reported few transport means whereas TV-ownership is widespread. This could however be related to the higher population density in South-Western Nigeria with corresponding amenities (e.g. electricity)[6] and transport network (e.g. road infrastructure and transport means). Care should therefore be taken in interpreting each of these indicators individually as an indicator of capital across the states.

Table 8 Ownership of transport and television at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Any transport means	91%	98%	22%	80%	72%	76% (.00)
- Bicycle	57%	72%	14%	72%	50%	56% (.00)
- Motorcycle	54%	33%	8%	32%	30%	33% (.00)
- Car or larger	6%	17%	8%	11%	4%	9%
Television	22%	39%	64%	11%	7%	26% (.00)

The various capital items - agricultural capital, motorized transport and TV – were also combined into a single capital indicator: the number of categories of capital items owned. On average, 44% of households reportedly did not own any of these capital categories, whereas 33% owned one, 19% owned two and 3% owned three. Figure 2 presents the distribution over the surveyed states – showing that ownership of these capital categories by rice producing households is substantially less common in Taraba and Benue states.

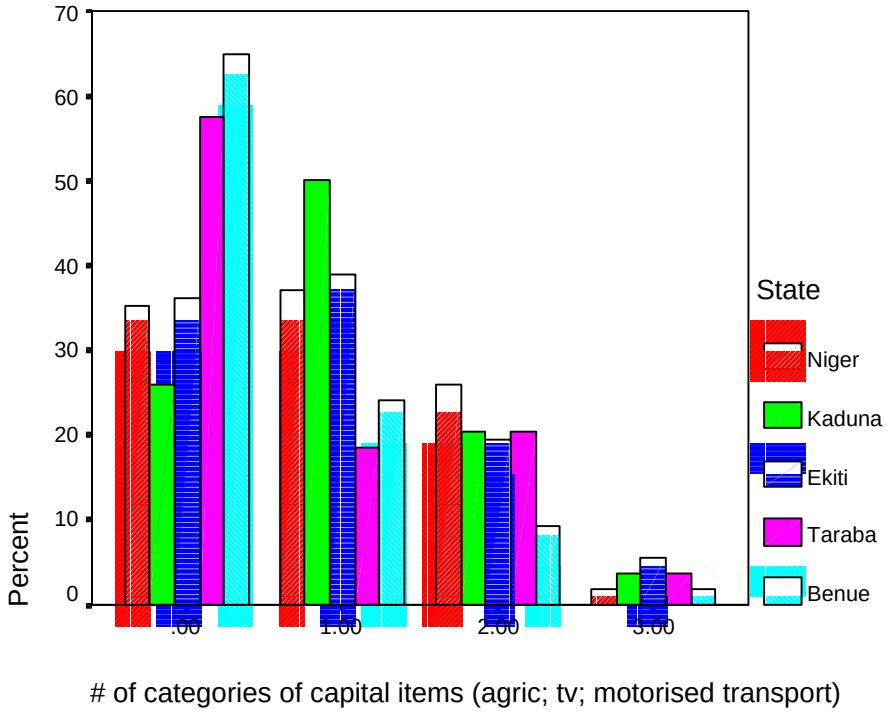

Figure 2 Number of categories of capital items owned at the farm level reported by state

[6] Indeed, the surveyed villages in Ekiti state have the highest relative level of such utilities as electricity and piped water – see Table 14.

Credit potentially can help alleviate capital constraints. However, most credit was reportedly short term (up to one year) and involved small amounts, mainly for crop expenses. Two-fifths of the households reported being recipients of credit, but at the same time nearly a third reported being provider of credit (Table 9). Although the provision of credit to others can be seen as a wealth indicator, it is noteworthy that 13% of the cases were both recipient and provider of credit (Table 10). This seems to indicate that the rice production enterprise both opens up the need for credit to cover crop expenses, but also opens the possibility of providing credit in view of substantial cash revenues upon output sale.

Table 9 Credit indicators at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Recipient of credit	59%	9%	33%	50%	48%	41% (.00)
Provider of credit	28%	30%	3%	48%	42%	32% (.00)

Table 10 Linkage between credit reception and provision at farm level in survey states (share of households, n=251)

		Provider of credit		
		No	Yes	Total
Recipient of credit	No	41%	19%	59%
	Yes	28%	13%	41%
	Total	68%	32%	100%

Credit received is mainly informal (39% of households). Formal credit was only reported by 5 cases (i.e. 2% of households). Although the number of formal credit cases is limited, it is noteworthy that formal and informal credit did not seem to differ substantially in terms of rates and conditions. Also data from informal credit providers correspond reasonably well with data from credit recipients (Table 11). Some cases reported payment in kind, for instance a credit of Naira 1,000 now for one bag of paddy at harvest. The most common sources of informal credit for credit recipients were local saving groups (19 cases), local money lender (12 cases) and relatives (10 cases).

Table 11 Selected credit indicators by source in survey states

		Formal credit recipient	Informal credit recipient	Informal credit provider
Annual rate	- Most common	10%	10% (32 cases) or 0% (31 cases)	10% (9 of 20 cases)
	- Average		7%	15.5%
Amount (Naira)	- Most common/range	N15-25,000	N 10,000	range N 500-150,000
	- Average		N 20,500	N 16,000
Duration	- Most common		3, 6, 12 months	5-6 and 12 months
(months)	- Average		7 months	7 months

Although credit use is significant, it should be recalled that the majority (59%) of rice-producing households reportedly did not receive any credit – either formal or informal. The most common reasons for non-use of formal credit was that it was either not available locally or difficult to obtain. In contrast, the most common reason for non-use of informal credit was that the household had no need (Table 12). These household data are in line with the village level data: 15% of villages reported access to formal credit sources, and 76% of villages to informal credit sources.

Table 12 Reasons for not using credit indicators at farm level in survey states (share of non-users)

	Formal credit (n=242)	Informal credit (n=157)
No need	10%	42%
Too expensive	5%	10%
Not available locally	48%	20%
Difficult to obtain	38%	28%

3.3 Economic activities of rice producers

Rice production is predominantly a rural activity. Indeed, crop production is reportedly the main economic activity at the village level across the surveyed states. Nearly all villages reported upland crops as one of their main three economic activities, 88% did the same for lowland crops and 54% did so for livestock. The ranking of each economic activity confirms the importance of crop production as economic activity at the village level. The relative importance of the economic activities varies over the surveyed states. Noteworthy is the limited importance of lowland crops in Ekiti state (reflecting in part the limited lowland area), and the corresponding importance of crafts and commerce. In the other states the relative importance of upland and lowland crops is quite balanced, lowland crops being relatively more important as economic activity at the village level in Niger and Benue state, and upland crops in Taraba and Kaduna states (Table 13).

Table 13 Relative importance of different economic activities at village level in survey states (share of villages within column)

State / Activity	Niger (n=8)		Kaduna (9)		Ekiti (6)		Taraba (9)		Benue (9)		Overall (41)	
	UW	*W*	UW	*W*	UW	*W*	UW	*W*	UW	*W*	UW	*W*
Upland crops	100%	*71%*	100%	*85%*	100%	*100%*	89%	*81%*	100%	*74%*	98%	*81%*
Lowland crops	100%	*92%*	100%	*81%*	50%	*33%*	89%	*70%*	89%	*85%*	88%	*75%*
Livestock	38%	*13%*	78%	*26%*	33%	*11%*	44%	*22%*	67%	*22%*	54%	*20%*
Commerce	0%	*0%*	11%	*4%*	67%	*28%*	44%	*15%*	11%	*7%*	24%	*10%*
Craft industry	0%	*0%*	0%	*0%*	50%	*28%*	0%	*0%*	0%	*0%*	7%	*4%*
Fisheries	13%	*8%*	11%	*4%*	0%	*0%*	33%	*11%*	33%	*11%*	20%	*7%*

UW: Un-weighted frequency, activity being reported amongst 3 most important; W: weighted frequency, with weight 1 for most important, 0.67 for second most important and 0.33 for third most important.

The predominantly rural location of the surveyed rice producing villages is also confirmed by the distance to the nearest town, amounting to 40 km on average. However, this distance is substantially more for Benue state, and substantially less for Ekiti state (Table 14 – first layer). Proximity to a town in part explains the relative importance of commerce and crafts at the village level in Ekiti state. The villages in Ekiti state are also relatively more favorably endowed with such utilities as piped water and electricity (Table 14).

Table 14 Selected village level indicators in survey states (% reflects share of villages within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Distance to nearest town (km, average)	32 b	41 b	8 a	31 b	72 c	40 (.00)
Piped water in village	13%	22%	50%	11%	0%	17%
Electricity in village	38%	67%	83%	0%	11%	37%

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The village itself frequently (44%) functions as an important market – either by being the main or secondary market for the village. Still, 56% of the surveyed villages did not consider their village as

one of their two main markets. These villages were split in those that still had another market located within a 5 km radius (32% of villages) and those that had to travel further a field (24%). Such remoteness from their main markets was particularly common in Niger state.

Table 15 Village level market access in survey states (share of villages within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Village main market	25%	67%	33%	11%	0%	27%
Village secondary market	13%	0%	50%	22%	11%	17%
Other market within 5 km	0%	11%	17%	56%	67%	32%
No market within 5 km	63%	22%	0%	11%	22%	24%

3.3.1 Crop production

Rice stands out as the main land use (in terms of crop area) for rice producing households. Of the 7.8 ha of cropped land in average, 3.3 ha are devoted to rice. The prominence of rice in terms of land use holds across the surveyed states and is in part related to the used sampling frame, whereby all surveyed farmers are rice farmers. Still, it is noteworthy that rice area is typically larger than each of the individual crops, and even tends to be larger than all other cereal crops combined. Similarly, rice area tends to be significantly larger than the area devoted to pulses, roots and tubers, other annuals and perennials (Table 16).

Sorghum and maize tend to be the next most prominent crops in terms of area for rice producing households. In Niger and Kaduna states, the aggregate sorghum and maize area even approximates the average rice area. Groundnut, yam and cassava are the other main crops that can be found across the surveyed states, with a number of other crops being only of local importance.

Table 16 Land use at farm level in survey states (average ha per farm household)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Rice	1.8 ab	2.5 b	1.3 a	7.7 c	2.6 b	3.3 (.00)
Sorghum	1.3 c	1.0 bc	0.0 a	1.9 d	0.7 b	1.1 (.00)
Maize	0.6 b	1.5 d	0.1 a	0.9 c	0.3 ab	0.7 (.00)
Other cereals	0.3 b	0.4 b	0.0 a	0.3 b	0.0 a	0.2 (.00)
Groundnut	0.4 b	0.4 b	0.0 a	1.1 c	0.3 ab	0.5 (.00)
Other pulses	0.5 bc	0.2 ab	0.0 a	0.6 c	0.2 ab	0.3 (.03)
Yam	0.7 bc	0.4 ab	0.4 a	0.3 a	1.0 c	0.6 (.00)
Cassava	0.3 a	0.4 a	0.5 a	1.1 b	0.6 a	0.6 (.00)
Other roots & tubers	0.1 a	0.1 a	0.2 b	0.0 a	0.0 a	0.1 (.00)
Other annuals	0.4	0.1	0.1	0.5	0.4	0.3 (NS)
Other perennials	0.0 a	0.0 a	0.2 b	0.2 b	0.0 a	0.1 (.02)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The rice producing households reported 6 productive fields on average, with state averages ranging from 4.5 (Ekiti) to 7.4 (Niger). Of these 6 fields, 2 fields were used for rice production on average – a number which is relatively constant across the surveyed states with the exception of Ekiti state (where only one rice field was the rule - Table 17).

Rice is predominantly sole cropped in the surveyed states (85% households). Rice intercropping – predominantly with maize - is however common in Ekiti state and to a lesser degree in Taraba state (Table 17 – last layer).

Table 17 Selected land use indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Average # of productive plots	7.4 d	5.9 bc	4.6 a	5.4 b	6.2 c	6.0 (.00)
Average # of rice fields	2.1 bc	2.0 b	1.0 a	2.4 c	2.0 b	2.0 (.00)
Intercropping of rice (share of households)	0%	0%	56%	31%	0%	15%

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

Agricultural land tends to be single-cropped (i.e. one crop per field per year) across the surveyed states. Only 2% (6 cases) reported some form of double-cropping (in Niger and Benue state). The prevalence of single cropping reflects the typically limited growing season across the surveyed states in conjunction with limited irrigation facilities. However, the lack of double-cropping is also reported in the forest zone (Ezedinma, 2001). The prevalence of single-cropping implies that crops tend to compete for the same scarce resources within the limited growing season. This is particularly apparent for the upland ecologies, where the growing season of the various cereals tends to coincide (Figure 3).[7] In rainfed lowlands competition for land between the various crops tends to be less intense because of the likelihood of water excess, which reduces crop options other than rice. As a result, any maize cultivation in lowlands tends to be either early or late season, so as to avoid the water excess periods. Access to irrigation opens the possibility of off-season cultivation (Figure 3) and thereby can reduce resource demand peaks. Comparing upland and lowland rice it also becomes apparent that (i) lowland rice tends to be planted one month later; and (ii) the lowland rice cycle tends to be substantially longer. This is likely linked to the incidence of flooding in the lowland fields, varietal use and the need to establish upland crops at the onset of the rainy season.

The land use categories (as reported in Table 16) normally exclude scattered on-farm trees. Such on-farm trees are relatively widespread (reported by three-quarters of the households, with an average of 45 trees per household) and can provide an additional and important source of income through sales (reported by 62% of households - Table 18). The most frequently reported trees include: mango (56% of households); cashew (28%) ; guava (14%) ; kola nut (13%); orange (10%); palm trees (10%); locust bean (7%). Other species are of local importance.

Table 18 Trees at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
On-farm trees reported	78%	70%	64%	69%	83%	73%
Any tree sales reported	76%	57%	50%	46%	74%	62%

[7] Figure 3 presents data for four states on aggregate. For the individual states see Annex 2.

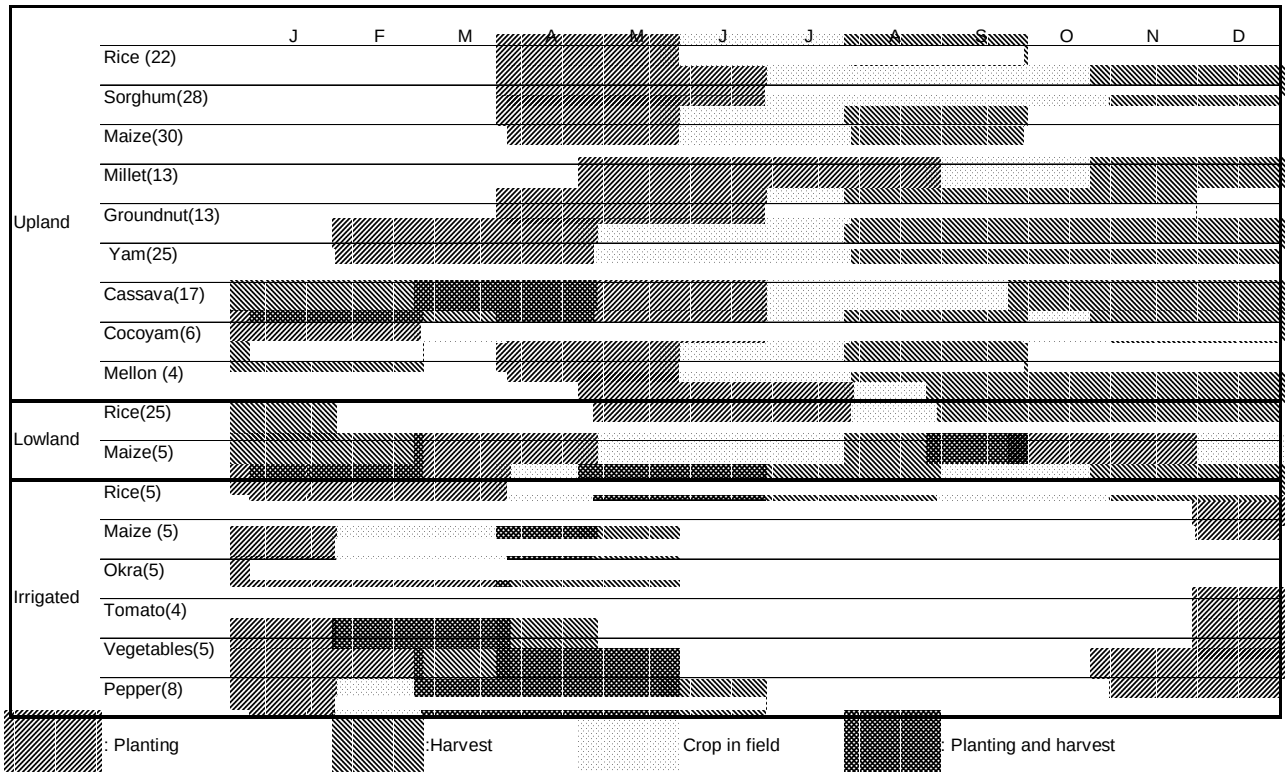

Figure 3 Cropping calendar by ecology (aggregate Niger, Kaduna, Ekiti and Benue states)

Figures in between brackets represent number of observations per crop. Demarcated are months for which activity per crop was frequently indicated.

3.3.2 Livestock production

Livestock ownership amongst rice producing households is widespread: 92% reported having some type of animals, most commonly goats/sheep (75%), poultry (52%), cattle (29%) and pigs (9%). Taken together, 83% owned some kind of mammal (Table 19).

Table 19 Livestock categories at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Mammals	85%	85%	64%	93%	80%	83% (.01)
Poultry	17%	24%	67%	82%	78%	52% (.00)
Any livestock (mammals or poultry)	91%	87%	90%	96%	94%	92%

Table 20 presents the average herd composition in terms of numbers of heads. On average, the herd comprises 7.5 goats/sheep, 3 cattle, 0.8 pig and 12 chickens. However, these averages mask significant differences between the various states and the rice producing households. Work oxen (included under cattle) were only reported by rice producing households in Taraba state.

Table 20 Livestock numbers reported at farm level in survey states (average # of heads per household, n=251)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
# of cattle	2.5 a	8.9 b	0.0 a	3.1 a	0.0 a	3.1 (.00)
# of goat/sheep	7.9 b	6.6 b	3.5 a	11.1 c	7.3 b	7.5 (.00)
# of pigs	0.0 a	2.1 b	0.0 a	0.7 a	0.9 a	0.8 (.01)
# of poultry	2.8 a	7.7 a	9.2 a	24.4 c	16.7 b	12.4 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The livestock enterprise can provide an important additional source of cash income. Table 21 shows selected indicators for livestock sales. The number of heads sold reflect the underlying herd composition. The cash annual income for animal sales however also reflects the type of animal sales, and thereby is more closely related to the sale of cattle. On average, rice farm households reported 1.2 livestock sales per year.

Table 21 Livestock sold over last year at farm level in survey states (average per household, n=251)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
# of heads sold per type						
- Cattle	0.7 b	1.6 c	0.0 a	0.4 ab	0.0 a	0.6 (.00)
- Goat/sheep	2.4 c	1.4 ab	0.8 a	2.8 c	1.6 b	1.9 (.00)
- Pigs	0.0	0.9	0.0	0.2	0.7	0.4 (.18)
- Poultry	1.0 a	1.3 ab	4.0 bc	7.0 d	4.1 c	3.4 (.00)
Lump sum received for animal sales (N, 2001)	15,800 bc	48,400 d	2,900 a	21,500 c	8,100 ab	20,500 (.00)
# of livestock sales 2001	1.1 b	1.4 bc	0.6 a	1.6 c	1.3 b	1.2 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

3.3.3 Non-agricultural activities

Over three-fifths (62%) of the households reported some source of off-farm income (Table 22). Most commonly (26% of overall cases) this implied commerce. Other reported sources include salaried work (7%); transport (5%); hunting & fishing (6%) and a miscellaneous group comprising different jobs & enterprises (16%).

Table 22 Off-farm source of income at farm level in survey states (share of households within column)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Off-farm source of income	52%	65%	58%	91%	44%	62%

3.3.4 Relative importance of activities

Although non-agricultural activities are common for rice producing households, agricultural farm activities still represent the main source of income on an annual basis for nearly all households (97%). Only 4% of households indicated that off-farm activities represented the main source of income on annual basis. Within the farm activities, crop farming stands out as the main farm activity for all but one farm household.

The rice producing farm households were also asked to indicate their most important cash and food crops (Table 23). A number of issues stand out. First, rice clearly is seen as the main cash crop for rice producing households – reported by 92% of the households and a finding consistent across the

various states. Other cash crops grown by the rice producing household are considered substantially less important than rice as a cash crop – 10% of households reporting yam and other crops being even less common. Second, rice clearly is not seen as the major food crop for rice producing households – reported by only 7% of the households with a maximum of 20% in Niger state. Depending on the state, the main food crop for the rice producing household tends to be another cereal (sorghum and maize, particularly in Niger, Kaduna and Taraba state) or roots & tubers (yam and cassava, particularly in Benue and Ekiti state).

Table 23 Most important cash and food crop at farm level in survey states (share of households within column, multiple response in case of ties)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Most important cash crops						
- Rice	91%	94%	92%	85%	100%	92%
- Yam	33%	2%	3%	11%	0%	10%
- Cocoa	0%	0%	6%	0%	0%	1%
- Other	0%	4% (maize, cassava)	0%	4% (groundnut cowpea)	0%	2%
Most important food crops						
- Maize	19%	80%	0%	59%	0%	34%
- Sorghum	78%	11%	0%	37%	15%	30%
- Yam	2%	11%	61%	0%	67%	26%
- Cassava	0%	0%	6%	2%	46%	11%
- Rice	20%	2%	11%	4%	0%	7%
- Other	2% (millet)	0%	22% (coco yam)	0%	4% (sweet potato)	4%

3.4 Dynamics of rice enterprise

Rice production is considered indigenous in almost all rice growing villages surveyed, with the exception of some villages in Kaduna state and most villages in Ekiti state (Table 24 – first layer). Still, even if not indigenous, rice production has occurred within each surveyed village for at least 10-15 years. Some non-indigenous villages report rice growing periods ranging from 30 to 60 years. Two issues thereby warrant highlighting. First, rice production is long established in each of the surveyed villages – even if rice was not an indigenous crop. Second, the minimum 10-15 year period seems to correspond with the first imposition of the rice import ban in Nigeria.

On average, rice farmers reportedly have produced rice for 21 years – a finding consistent over the various states except for Niger state, where the average amounted to 25 years (Table 24 – second layer). The years of rice cultivation is however somewhat difficult to interpret as it is influenced by the age composition of the respondents. To correct for the age effect, Table 24 (third layer) also presents a rice expertise index – reflecting the share of the rice farmers' productive life that he was involved in rice production. On average, rice farmers have produced rice for 73% of their productive life – with some significant differences amongst states, consistent with whether rice is considered as indigenous crop at the village level. Again Niger state stands out – this time with a rice expertise index of nearly unity reflecting that farmers tend to have always produced rice.

Table 24 Selected indicators for duration of rice production in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Rice farming indigenous in village (share of villages)	100%	78%	17%	100%	100%	83%
Av. # of years farmer produced rice(n=249)	25 b	20 a	19 a	21 a	20 a	21 (.01)
Average rice expertise index [a] (age class 35-55 years only)	0.94 d	0.61 b	0.50 a	0.74 c	0.78 c	0.73 (.00)

[a] Index reflects share of productive life (PRODLIFE = AGE - 15) spent cultivating rice (YRSRICE). Calculated as REI = [YRSRICE] / [PRODLIFE] .
Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

Table 25 groups the reasons for starting rice production for the household. The prevalent reason for initiating rice production is that farmers consider it an important cash crop and source of income – reported by 94% of households and consistent over the surveyed states. The second most common reason for initiating rice production is that farmers consider it an important food crop and source of food – reported by 17% of households with some variation over the states, and with over 40% in Niger state.

Based on the various indicators, it seems safe to conclude that Niger state can be considered as the most traditional rice producing state amongst the surveyed states (i.e. with the longest rice growing tradition).

Table 25 Reasons for starting rice cultivation in survey states (share of households within columns)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Cash crop/income	93%	98%	92%	94%	93%	94% (.66)
Food crop/consumption	41%	11%	19%	2%	11%	17% (.00)
Other	6%	0%	3%	8%	6%	4%

Table 26 presents the reported rice consumption trends at the village level. Most of the villages (70%) reported an increase in rice consumption at the village level. In 8% of the villages there was a reported shift from local to imported rice - particularly in Ekiti and Kaduna state. The shift to imported rice in rice producing villages is both surprising and indicative of an underlying quality problem for local rice. According to the village level survey, local rice is available for purchase in all surveyed villages. However, more surprisingly, imported rice is now available in 66% of the surveyed villages. This highlights two important issues. First, that rice consumers increasingly have the choice between local and imported rice – even in rural areas. Second, that rice producers increasingly face the competition of imported rice – and that this competition reaches right into their village.

Table 26 Rice consumption changes at village level in survey states (share of villages within columns)

	Niger (n=8)	Kaduna (9)	Ekiti (5)	Taraba (9)	Benue (9)	Overall (40)
Decrease		11%		11%		5%
No change	50%	33%				18%
Increase	50%	44%	60%	89%	100%	70%
Shift towards imported		11%	40%			8%

Table 27 presents the reported rice area trends at the village and farm level. At the village level, the overall tendency of rice area over the last decade is positive. However, this masks some differences between the surveyed states: with the tendency being outright positive in Benue and Kaduna states,

neutral in Niger and Taraba states and outright negative in Ekiti state. The farm level data for the last five years to a large extent confirm the same mixed picture. On average, rice producing farm households are about equally divided between those that increased their rice area, those that maintained their rice area and those that reduced their rice area. Again only Ekiti state confers a negative trend, where a clear majority of rice producing households decreased their rice area.

Table 27 Rice area trends at village and farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Change in village rice area over last decade (share of villages, n=41)						
- Increase	50%	78%	17%	44%	100%	61%
- No Change	0%	0%	0%	0%	0%	0%
- Decrease	50%	22%	83%	56%	0%	39%
Change in farm rice area change over last five years (share of hh, n=251)						
- Increase	41%	41%	19%	36%	41%	37%
- No Change	48%	30%	8%	32%	46%	34%
- Decrease	11%	30%	72%	32%	13%	29%

Table 28 presents the reported reasons for the rice area trends at the village and farm level. The main reason for area increase coincides for both the village and farm level and reiterates the importance of rice as a source of cash and income. The second most common reason for area increase at the farm level relates to family growth. The other reasons at both the village and farm level are varied without any other clearly standing out.

The reasons for rice area decrease are varied. Although the types of reasons correspond between the village and farm level, their relative ranking differs. At the village level a-biotic production problems (e.g. soil & water related, including flooding) stand out as the most common reasons for area decrease, followed by biotic production problems (i.e. weeds, pests and diseases, including birds). At the farm level resource availability stands out as the most common reason for area decrease.

Table 28 Reasons for rice area changes at village and farm level in survey states

	Village level	Farm level
Reasons for rice area increase	- cash/income (11 of 25 villages) - input availability (5) - land availability/development (4) - mechanization availability (4) - population growth (3) - shift towards rice (3)	- cash/income (35 of 92 cases) - family growth (15) - price/profit (6) - land availability (6) - cash & food (6) - production (6) - labor availability (5)
Reasons for rice area decrease	- a-biotic production problems (10 of 16 villages) - biotic production problems (6) - input availability (5) - labor availability (3) - credit availability (3)	- resource availability (38 of 72 cases) - biotic production problems (12) - input availability (10) - labor availability (8) - a-biotic production problems (5)
Reasons for stopping with rice production	- biotic problem (8 of 14 villages) - a-biotic problem (7) - input availability (3)	- resource availability (11 of 29 cases) - personal problem (4) - biotic production problems (3) - a-biotic production problems (3)

Includes multiple responses and main response categories.

Table 29 presents the reported incidence of discontinuation of rice production at the village and farm level. At the village level, a third of the villages reported at least some villagers stopping rice production over the last decade. This was however substantially more widespread in Ekiti state, in line with the negative trend in rice area reported for that state. At the farm level, 12% of the current rice producing households reported having ever discontinued rice production. Again, this was relatively more common for Ekiti state but also for Taraba state. The reasoning for the discontinuation of rice production is similar to the reasons reported for area decrease (Table 28). At the village level, the discontinuation of rice production is often linked to biotic and a-biotic production problems. At the farm level, resource constraints are the primary reason.

Table 29 Discontinuation of rice production at village and farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Some villagers have stopped growing rice in past decade (share of villages)	25%	33%	83%	33%	11%	34%
Share of households that ever stopped producing rice	4%	6%	19%	22%	9%	12% (.01)

Table 30 compiles area change indices for the main crops at the farm level. The rice data are based on the same data as presented in Table 27 – although in a format that now allows for comparison with the other main crops. The data reiterate the positive area trend for rice in Niger and Benue state, and the negative trend for Ekiti state. The table also shows that in Ekiti rice area seems to have been substituted by roots & tubers (particularly yam and a lesser degree cassava) – which was enabled by the prevalence of upland rice. Roots & tubers were reportedly also clearly on the rise in Benue state. For the other states and crops the picture is more ambivalent.

Table 30 Area change index over last five years for main crops at farm level in survey states (average per household)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Rice	0.30	0.11	-0.53	0.04	0.28	0.08
Sorghum	0.04	-0.17	0.00	0.11	0.09	0.02
Maize	-0.07	-0.09	0.17	0.17	-0.02	0.02
Yam	0.04	0.02	0.56	0.04	0.41	0.19
Cassava	0.00	0.04	0.33	0.09	0.33	0.14

Index: 0: No area change; +1: Area increase; -1: area decrease

3.5 Typology of rice producers

Cluster analysis is one way of analyzing the diversity of rice producing households in terms of their resources and activities. A cluster analysis was applied to a selection of the foregoing variables to derive an aggregate typology of rice producers.[8] Four clusters of rice producing households were retained with characteristics as reported in Table 31.

The first cluster is the largest – with about half the rice producing farm households and thereby can be seen as the overall 'typical' rice producing household. This cluster can be typified as relatively *'medium-scale' diversified farmers* (6 ha). They grow a range of crops, including 2 ha of rice – mainly lowland - and a larger area with a number of other upland crops (4 ha). The household has a

[8] The variables included are indicated by an '*' in Table 31. The analysis used was a hierarchical cluster analysis with between-group linkages and squared Euclidean distances. All variables were standardized on a 0-1 scale.

limited resource base and household income is variously supplemented. External input use (particularly fertilizer) is widespread – but mechanization is limited. Fallowing is limited.

The second cluster can be typified as relatively *'resource-rich & large-scale' farmers*. They cultivate 13.5 ha on average, growing 6.5 ha of lowland rice and a number of other upland crops (7 ha) and with significant livestock (both large and small ruminants). Rice production is significantly above average at approximately 8 tons of paddy per year. Livestock and off-farm income are important. The household is large (17 members) and is relatively rich (e.g. possession of capital goods, limited hiring out of labor), often providing credit to others. Tends to be member of agricultural organization. External input use – both fertilizer and herbicides - is widespread and the use of tractors is common. Plots are large (> 2ha).

The third cluster can be defined as *'small-scale' upland farmers*, producing primarily rice and roots and tubers and using extensive rice production practices and fallowing. Both the household (< 10 members) and plots are small (< 1ha). The small-scale also implies a limited number of household members working on-farm.

The fourth cluster can be typified as *'resource-poor & medium-scale' farmers*. They cultivate 6 ha, devoting half their crop area to grow rice (3 ha) – primarily lowland rice - and some upland crops (3 ha). The household comprises a large family (17 members) but has a limited resource base (e.g. limited possession of capital goods, frequent hiring out of labor). Household income is supplemented with livestock (small ruminants and poultry) and off-farm income. Tree product sales are not important – likely because many of these households are non-natives. Fertilizer and tractor use is widespread, but herbicide use limited. Fallowing is also common.

It is somewhat problematic to capture the various characteristics of each producer cluster in a simple label. Still, with the risk of being incomplete, the four clusters can be labeled:

1. 'medium-scale' diversified farmers;
2. 'resource-rich & large-scale' farmers;
3. 'small-scale' upland farmers;
4. 'resource-poor & medium-scale' farmers.

It should be noted that the labels in terms of 'scale' and 'resources' are always relative. They are used here to typify the surveyed population – for instance, even the 'large-scale' farmers crop area of 13.5 ha may still be considered 'small-scale' when compared to other standards. Also, all clusters refer to rice producing households – i.e. all are rice farmers. Still, cluster 1 devotes relatively less area to rice production (approximately a third of crop area) than the other clusters (approximately 50% of crop area) – hence that the first is labeled 'diversified'.

The clusters are linked to the geographic distribution of the rice producers (Figure 4). The first and largest cluster ('medium-scale' diversified farmers) is representative of the rice producers in Niger, Benue and Kaduna state. The second cluster ('resource-rich & large-scale' farmers) is representative of Taraba state – but also includes farm households from various other states. The third cluster ('small-scale' upland farmers) is representative of Ekiti state. The fourth and smallest cluster ('resource-poor & medium-scale' farmers) includes another subset of farmers from primarily Taraba state.

Table 31 Selected characteristics of rice producer clusters

Indicator \ Cluster	Cluster 1 (n=125)	Cluster 2 (n=71)	Cluster 3 (n=37)	Cluster 4 (n=15)	Overall (n=248)
Land type (ha)					
- Upland area*	4.4 a	6.9 b	2.7 a	3.9 a	4.9 (.00)
- Lowland area*	1.4 ab	6.4 c	0.3 a	2.3 b	2.7 (.00)
- Irrigated area*	0.2 b	0.0 a	0.0 a	0.0 a	0.1 (.01)
# of plots	6.4 c	5.9 bc	5.2 ab	5.1 a	6.0 (.00)
Land use (ha per hh)	6.1 b	13.4 c	3.0 a	6.3 b	7.8 (.00)
- Rice	2.0 ab	6.6 c	1.3 a	3.3 b	3.3 (.00)
- Non-rice cereals	2.0 b	3.0 c	0.2 a	1.9 b	2.0 (.00)
- Pulses	0.7 a	1.5 b	0.1 a	0.1 a	0.8 (.00)
- Roots & tubers	1.2 b	1.6 b	1.0 ab	0.4 a	1.2 (.06)
- Other annuals	0.2 ab	0.6 b	0.1 a	0.5 b	0.3 (.06)
- Perennials	0.0 a	0.1 ab	0.2 b	0.0 a	0.1 (.03)
Fallow area reported*	4%	45%	81%	73%	32%
Rice production (MT per year)*	3.5 a	7.9 b	2.7 a	4.4 a	4.7 (.00)
Livestock production					
# of cattle*	2.7 ab	5.5 b	1.1 a	1.3 a	3.2 (.09)
# of goat/sheep*	6.4 a	9.9 b	3.9 a	16.9 c	7.6 (.00)
# of pigs*	1.0	0.9	0.1	0.0	0.8 (.35)
# of poultry*	7.3 a	19.2 b	10.2 a	28.3 c	12.4 (.00)
Other sources of income					
- Tree product sales*	65%	63%	62%	20%	61%
- Off-farm income*	42%	92%	54%	100%	62%
Selected characteristics household head					
- Age*	46 a	44 a	51 b	44 a	46 (.04)
- Can read*	57%	93%	76%	67%	71%
- Education beyond primary/koranic	21%	38%	25%	27%	27%
- Non-native*	2%	13%	14%	53%	10%
Household members	12.4 a	16.8 b	9.6 a	17.3 b	13.5 (.00)
- # Working mainly on-farm*	5.4 b	5.5 b	2.7 a	6.6 b	5.1 (.00)
- # Working mainly off-farm*	1.7 b	3.1 c	1.5 ab	0.5 a	2.0 (.00)
- # dependants	5.3 a	8.2 b	5.4 a	10.2 b	6.5 (.00)
Credit market linkages					
- Recipient credit*	43%	38%	32%	47%	40%
- Provider of credit*	22%	65%	5%	27%	32%
Labor market linkages					
- Hire in labor*	84%	97%	97%	93%	90%
- Hire out labor*	46%	23%	5%	67%	35%
Selected wealth indicators					
- Possession motorized transport	35%	56%	24%	7%	38%
- Possession TV	14%	37%	57%	0%	26%
- Possession ag. equipment	9%	35%	16%	0%	17%
# of capital categories reported*	0.6 b	1.3 c	1.0 c	0.1 a	0.8 (.00)
Member agricultural organization*	44%	78%	35%	40%	52%
Technology use					
- Use of fertilizer*	89%	87%	5%	100%	76%
- Use of herbicide*	70%	93%	22%	33%	67%
- Use of tractor*	12%	69%	3%	100%	32%

* Standardized variables included in cluster analysis. % refer to share of cases (i.e. surveyed households) within column, unless otherwise indicated. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

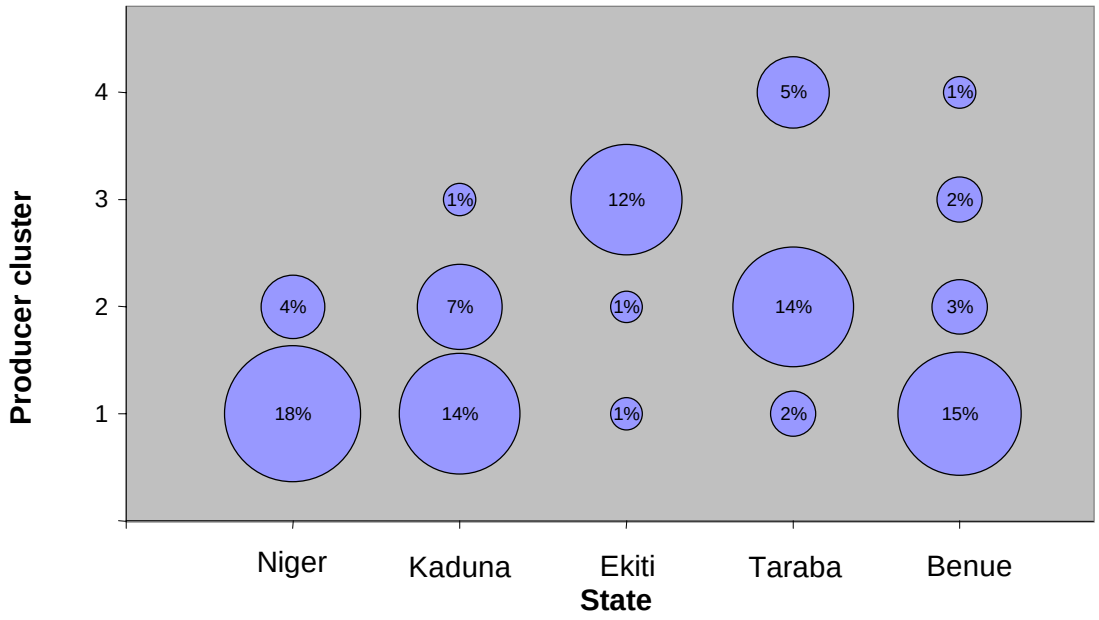

Figure 4 Distribution of rice producer clusters in survey states (share of households, n=248)

3.6 Discussion

The present chapter has shown that rice producing farm households are primarily small-holders with limited capital resources. They cultivate an average of 8 ha with crops per year – of which 3.3 ha are devoted to rice. Crop farming typically is the main source of household income, but households variously supplement their income with livestock and off-farm sources of income. Of all crops rice is clearly perceived as the main cash crop for the household. Its role as food crop is only of secondary importance. Indeed, the prevalent rationale for initiating and continuing rice production is that rice is perceived as an important cash and income deriving activity. The subsequent chapter will characterize the rice production practices used by the rice producers.

4 Rice production characteristics

The present chapter characterizes rice production so as to answer a number of questions. For instance, what are the current crop management practices for rice (varieties, fertilizer use, mechanization…)? What are the rice yields? How are these factors determined by ecology? What are the main current rice production systems? Which major technological changes have occurred? Is there a gender division of labor? What are the production problems farmers are actually facing in the field? The chapter first characterizes rice production at the field level – describing the various production practices sequentially from land preparation to harvest and including descriptions of rice ecology, crop rotation and crop calendar. It subsequently gives a brief review of the gender division of labor, followed by a typology of rice production systems. It subsequently reviews technological change with particular emphasis on external input use. The chapter ends with a description of production problems as perceived by the farmers – followed by a brief discussion/summary.

4.1 Rice production practices at field level

The survey focused the rice production questions on one specific rice field. In case the rice farmer cultivated more than one field, the selected field was typically the largest. The focus on specific field facilitates the estimation of technical coefficients and other parameters.

4.1.1 Rice ecology and water management

The rice ecology is a major factor determining the rice production system – e.g. in terms of biotic & a-biotic stresses, intensification and mechanization possibilities and opportunity cost of land. The surveyed rice fields fall within the three main rice ecologies:

- Rainfed upland (30% of surveyed rice fields);
- Rainfed lowland – i.e. without water control (65%); and
- Irrigated – i.e. lowland with water control (6%).

The relative importance of the reported rice ecologies is clearly a function of the targeted states and the sampling frame used – and may thereby differ from actual nation wide prevalence. Still, the ecological distribution of surveyed rice fields is in line with earlier estimates. It also seems to confirm the relative prevalence of lowland over upland rice.

Irrigation implies the ability to water and drain the field when the farmer wants to. In this sense, 11 fields could be considered as 'irrigated'.[9] There were however 3 rice fields that farmers considered as 'irrigated' although the farmer could not at all times water and drain the field. This nonetheless implies a degree of water control which was reportedly absent in the 'rainfed' lowland fields. The irrigated category was therefore extended to also encompass these cases and will be referred to as (semi-)irrigated hereafter – i.e. fields with some degree of water control. All (semi-)irrigated fields relied on surface/gravity irrigation. In irrigated fields, a nominal water charge of Naira 50 per field was common (9 out of 11 fields). In semi-irrigated fields no water charge was reported. (Semi-) irrigated fields are typically bunded (93%).

The rainfed lowlands have no water control. Bunding is also uncommon in rainfed lowland fields (only 14% of lowland fields - concentrated in fields with limited flooding). The rainfed 'lowland' category in this study comprises various types of lowlands without water management. For instance, in terms of hydrology the lowlands can be divided into three different sub-categories:

- *Lowland without flooding* (14% of surveyed rice fields): This comprises land that is considered as lowland by farmers, but which reportedly does not experience any flooding or waterlogging

[9] It can be argued that none of the surveyed 'irrigated' fields has complete water control – particularly outside the main cropping season. Indeed, none of the surveyed fields was double cropped with rice, typically for not having sufficient water control to allow for a second rice crop.

during the year. Based on the available data it is not possible to assess whether this land is hydromorphic (i.e. with the water table within the root zone at some time during the year) or 'virtual' lowland (i.e. considered as lowland by farmers, but strictly speaking upland with the water table at all times below root zone). This subcategory can therefore be viewed as a transitional category between 'strict' lowland with flooding/waterlogging at some point within the year (i.e. plant relies on rainfall and ground/flood water) and 'strict' upland (i.e. plants rely purely on rainfall).

- *Lowland with limited flooding (≤ 1m) and/or waterlogging* (37% of surveyed rice fields): This comprises land that is traditionally considered as lowland – both by farmers and scientists. The 93 fields reported in this category comprise 55 fields with limited flooding (varying from 10 cm to ≤1m) and 76 cases that were considered waterlogged (typically during the rainy season).
- *Lowland with substantial flooding (>1 m)* (14%): Maximum flood levels in these fields exceed one meter.

The previous subdivision takes into account maximum flooding depth. However, in terms of flooding the frequency and duration of flooding are also important. Table 32 shows the linkage between flooding frequency and flooding depth. Forty percent of fields subject to flooding are flooded several times a year, but this typically implies flooding depths are limited. Twenty-one percent of fields subject to flooding are flooded once a year, but this typically implies substantial flooding depths. Still, approximately 40% of the fields subject to flooding are not flooded every year, and this is proportionally equally common for fields subject to limited and substantial flooding. The average duration of flooding in the flooded lowland fields was reportedly 44 days (based on 88 cases), with a minimum of 2 hours and a maximum of 150 days. There was no significant correlation of flooding duration with flooding depth and no significant difference in terms of duration between limited and substantial flooding levels. On average, lowland fields reportedly retained water in the soil profile for 2.2 months (172 lowland fields) after the rains had ceased.

Table 32 Frequency of flooding for lowland fields (share of lowland fields subject to flooding, n=80)

	Not every year	Once every year	Several times per year	Overall
Lowland with limited flooding (≤1 m)	24%	5%	31%	60%
Lowland with substantial flooding (>1 m)	15%	16%	9%	40%
Overall	39%	21%	40%	100%

In terms of topography the lowland fields (173 cases, including irrigated) can be divided into three different sub-types:

- floodplain (> 200 m wide, drains into river - 77% of lowland fields)
- valley bottom (<200 m wide, drains into stream - 16%);
- depression (closed area that does not directly drain into stream - 7%).

The hydrology and topography imply somewhat different problems and opportunities for intensification of rice production. Table 33 presents the linkage between hydrology and topography of the surveyed fields. The table reiterates that most of the surveyed lowland fields are located in floodplains and are subject to limited flooding. Table 34 shows the distribution of the detailed rice ecologies over the survey states. The semi-irrigated rice fields are concentrated in Niger state. The fields subject to substantial flooding levels are concentrated in Taraba state and to a lesser degree Niger state – an issue related to the Niger and Benue rivers in the surveyed floodplain areas in these states. Notwithstanding the potential importance of both hydrology and topography, the subsequent presentation of results will focus on the lowland category as a whole to maintain the big picture and compare between the main ecologies. What should be retained however, is that the lowland ecology in this study comprises a mixed bag of sub-ecologies.

Table 33 Topography and hydrology of selected lowland fields (share of lowland fields, n=173)

	Floodplain	Valley bottom	Depression	Overall
Lowland w/o flooding	18%	1%	1%	20%
Lowland w limited flooding (≤1 m)	39%	9%	4%	52%
Lowland w substantial flooding (>1 m)	16%	2%	3%	20%
(Semi-)Irrigated	4%	4%	0%	8%
Overall	77%	16%	7%	100%

Table 34 Rice ecology of selected field in survey states (share of households)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Upland	0%	48%	94%	9%	20%	30%
Lowland w/o flooding	24%	11%	3%	15%	11%	14%
Lowland w. limited flooding (≤1 m)	32%	41%	3%	39%	59%	37%
Lowland w. substantial flooding (>1 m)	19%	0%	0%	37%	9%	14%
(Semi-)Irrigated	26%	0%	0%	0%	0%	6%

4.1.2 Crop rotation and fallowing

The rice ecology to a large extent influences crop rotation practices. Table 35 presents the reported land use intensity in the surveyed field for the last 3 years. The table clearly shows that the prevalent practice (75%) – across ecologies – is the continuous year in-year out cultivation of one crop per year (i.e. with off-season fallow) over the three year period. However, the table also highlights an increasing land use intensity progressing from upland through rainfed lowland to semi-irrigated. Intermittent single cropping implies that the field was fallowed at least once during the main season over the three year period. This practice was reported for 22% of surveyed fields – but for up to 32% of upland fields and none of the (semi-)irrigated fields. Continuous cropping with double cropping implies that the field was cropped every main season and at least once during the off season over the three year period. This practice was reported for only 2% of the surveyed fields – but for none of the upland fields and up to 29% of the (semi-)irrigated fields.

The foregoing information is grouped in the land utilization index (Table 35 - last line) – whereby an index of one corresponds with an average of one crop per year. In view of the prevalence of the continuous single cropping across ecologies, all ecologies have an index close to unity. However, the index is above unity for irrigated fields in view of the incidence of double cropping. Similarly, the index is below unity for the rainfed ecologies, in line with the practice of fallowing.

Table 35 Land use intensity in selected field over last three years by rice ecology (share of surveyed rice fields)

	Upland (76)	Lowland (163)	(Semi-) Irrigated (11)	Overall (n=250)
Land use system				
- Intermittent single cropping	32%	20%	0%	22%
- Continuous single cropping	68%	79%	71%	75%
- Continuous cropping with double cropping	0%	1%	29%	2%
Land utilization index (# of crops last 3 years/3)	0.84 a	0.93 a	1.17 b	0.91 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

Table 36 presents the reported cropping history in the surveyed field for the last 3 years in more detail. It thereby distinguishes between three types of land use (rice, other crop and fallow) and the main season and off-season. Other crops in the main season included maize, sorghum, millet,

groundnut, beans and yam. Other crops in the off-season included sugarcane and potato. The table thereby adds the consideration of crop rotation to the land use intensities reported earlier. In this respect it is noteworthy that there is a marked decrease in crop rotation during the main season progressing from upland (30% of fields grow other crops than rice) through rainfed lowland (7%) to semi-irrigated (0%). The reverse is however true for off-season crop rotation – the production of non-rice crops being confined to the semi-irrigated surveyed fields.[10] The limited use of crop rotation in lowland rice fields is to a large extend explained by the hydrology of lowland rice fields (i.e. flooding and waterlogging), which typically limit the number of crop alternatives available during the main season. Table 36 also highlights that only 1% of the fields (2 cases) reported rice double cropping in the surveyed field – and that this practice was confined to the rainfed lowlands. Although these fields had no water control, their waterlogging was of such nature that it allowed for the cultivation of two crops.

Table 36 Crop rotation in selected field over last three years by rice ecology (share of surveyed rice fields, % are column based)

		Main season[1]	Off season[1]	Upland (76)	Lowland (163)	(Semi-) Irrigated (11)	Overall (n=250)
Intermittent single cropping	Intermittent rice-fallow	R/F	F	28%	20%	0%	21%
	Intermittent crop-fallow	R/O/F	F	4%	0%	0%	1%
Continuous single cropping	Continuous rice single cropping	R	F	42%	72%	71%	63%
	Continuous single cropping of rice and other crop	R/O	F	26%	7%	0%	12%
Continuous cropping with double cropping	Rice double cropping	R	R	0%	1%	0%	1%
	Rice/other crop double cropping	R	O	0%	0%	29%	2%

[1] R: Rice; F: Fallow; O: Other (i.e. non-rice) .

The foregoing shows that 22% of the surveyed fields where reportedly fallowed at least once during the main season over the three year period. Table 37 shows that, in addition, 27% of the surveyed fields had been fallowed before – i.e. fallowing was reported for half of the rice fields, with a marked concentration in upland fields. On average the surveyed field was last fallowed 6 years ago, for an average duration of 3.2 years (n=134). [11]

Table 37 Incidence of fallowing in selected field by rice ecology

	Upland	Rainfed lowland	(Semi-) Irrigated	Overall
No fallow reported	22%	60%	100%	51%
Last fallow more than 3 years ago	46%	20%	0%	27%
Last fallow during last 3 years	32%	20%	0%	22%

[10] This is however not necessarily true for the whole of Nigeria. Field observations in rainfed lowland rice fields in Ebonji state by the authors have shown the existence of double cropping systems rotating rice in the rain season on the flat with miscellaneous food crops grown on heaps in the off-season.

[11] In comparison, 31% of households reported having some of their fields fallow for the survey year (i.e. at the farm household level, not restricted to selected field). Such fallow fields were particularly widespread in Ekiti (upland ecology) and to a lesser degree Taraba. The reported fallow duration was on average 5 years (n=70 fields), but with 80% of the values being < 5.5 years.

4.1.3 Land preparation

Land preparation generally comprises a combination of land clearing, tillage and/or the use of herbicides. Land clearing is always manual, and primarily comprises the clearing with cutlass and removal of organic debris, pre-plant burning and stumping/felling (in upland areas). Land clearing is a widespread practice (83% farmers reporting), and nearly a universal practice for upland rice (Table 38). Tillage is primarily manual with hoes (58%), with the remainder using tractors (26%), zero-tillage (16%) and animal traction (2%). Manual hoe tillage tends to be the prevalent tillage practice across rice ecologies (Table 38). However, in upland systems, zero-tillage tends to be equally common (42% of upland rice fields). Mechanized tillage with four-wheel tractors and the few cases of animal traction tend to be concentrated in lowland rice, particularly floodplains, but some use of tractors is also reported for upland rice (18% of upland rice fields). In the semi-irrigated rice fields tillage was manual. The use of two-wheel tractors was not reported. Most common is to apply one single tillage operation (70% cases). The remainder is split between those that reported two tillage-operations (14%) and the use of zero-tillage (16%). Only a fraction of the farmers (12%) reportedly used herbicides (Gramoxone - paraquat) at the time of land preparation – with a marked concentration amongst semi-irrigated rice.

Land preparation practices are thus dependant on the rice ecology. In upland rice systems, farmers primarily use either zero tillage systems with manual land clearing (42% of upland rice plots) or manual tillage systems (40% of upland rice plots), and to a much lesser degree mechanized tillage (18% of upland rice plots). In rainfed lowland rice systems manual land clearing tends to be followed by manual tillage (62% lowland rice plots) and to a lesser degree mechanized tillage (31% lowland rice plots). In semi-irrigated rice systems land preparation tends to comprise a manual land clearing followed by manual tillage and the application of herbicides.

Physical obstacles such as stones and trees could jeopardize the potential for mechanization. Stones were reported in 13% of the surveyed fields and were reportedly more common in upland fields (29% of fields) compared to lowland (6%). The incidence of stones indeed reduces the likelihood of using traction (tractor or animal traction): stones are reported in only 3% of the fields using traction vs. 17% of the non-traction fields. Trees (either felled or standing) were reported in 60% of fields – but are more common in upland (76%) than lowland (54%) or irrigated (46%). The incidence of trees also reduces the likelihood of using traction (tractor or animal traction): trees are reported in only 46% of the fields using traction vs. 66% of the non-traction fields.

Table 38 Land preparation practices reported in selected field by rice ecology (% refers to share of surveyed rice fields)

	Upland	Lowland	(Semi-) Irrigated	Overall
Manual land clearing	97%	77%	71%	83%
Type of tillage operation [a]				
- None	42%	4%	0%	16%
- Manual	40%	62%	100%	58%
- Tractor	18%	31%	0%	26%
- Animal traction	0%	4%	0%	2%
Average # of tillage operations	0.7 a	1.1 b	1.3 b	1.0 (.00)
Distribution of # of tillage operations:				
- None	42%	4%	0%	16%
- 1 time	49%	80%	71%	70%
- 2 times	9%	15%	29%	14%
Chemical application	0%	11%	79%	12%

[a] Combinations of methods reported, so sum does not add up to 100%. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

4.1.4 Crop establishment

Crop establishment is always manual, with three modes of establishment being reported: drilling (or dibbling), broadcasting and transplanting. Mode of crop establishment is ecology dependant (Table 39): in upland rice fields, drilling is the prevalent practice, and in irrigated fields transplanting. Lowland rice fields present a more varied picture, with an emphasis on broadcasting and drilling and to a lesser degree transplanting. Rice seeds are generally kept from the previous harvest. The reported seed rate averages 75 kg per ha. The mode of crop establishment determines the corresponding labor use, with broadcasting being least labor intensive and transplanting the most (Table 40).

Overall, rice tends to be cropped as a sole crop. Rice intercropping was reported in 30% of the upland rice fields (particularly in Ekiti State), and 8% of lowland rice fields (particularly in Taraba State). Rice intercropping is primarily with maize – both in upland and lowland. In lowlands intercropping includes maize-rice relay cropping, whereby the maize is harvested prior to the incidence of flooding (e.g. Taraba state). Reported seed rates for the intercrop are low – averaging 2.5 kg per ha – in part due to intercropping only in part of the rice field.

In terms of the type of rice varieties used, farmers reported common use of both 'traditional' (56%) and 'improved' varieties (65%).[12] Use rates of 'improved' varieties are higher in the upland and irrigated surveyed fields (71-72%) compared to lowland fields (61%). However, in lowland and irrigated fields it is also common for farmers to use 'traditional' varieties. As a result, it is only in upland fields that use rates of 'improved' varieties clearly surpass 'traditional' varieties. At first glance this is remarkable, as upland rice is often considered as more 'traditional' and the upland ecology more heterogeneous compared to lowlands. However, the prevalent use of 'improved' varieties in uplands is to a large extent caused by Ekiti State, where surveyed farmers use of improved varieties is widespread (particularly ITA 150). Indeed, in the other upland fields, the balance of varietal use tilts towards 'traditional' varieties (60% vs. 52% for 'improved' varieties, n= 42).

Table 39 Crop establishment practices reported in selected field by rice ecology (share of surveyed rice fields)

	Upland	Lowland	(Semi-) Irrigated	Overall
Mode of crop establishment				
- Drill	72%	32%	21%	43%
- Broadcast	8%	37%	0%	26%
- Transplant	0%	18%	79%	16%
- Unspecified	20%	14%	0%	15%
Intercropping	30%	8%	0%	14%
Seed rate (kg/ha)				
- Rice	87 b	65 a	50 a	71 (.00)
- Maize	2.5 (n=21)	2.5 (n=8)		2.5
Type [a] of rice varieties used				
- Traditional	37%	63%	71%	56%
- Improved	72%	61%	71%	65%

[a] Based on farmer classification. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

[12] This classification is indicative and based on farmer classification - an issue elaborated in section 4.4.2.

Table 40 Labor use for crop establishment (labor days per ha) in selected field by rice ecology

	Mean	N	Std deviation
Broadcasting	9	65	12
Drilling	23	96	19
Transplanting (incl. nursery management)	34	29	18

4.1.5 Weed management

Weeding is a near universal practice. Only 3 cases (1%) reportedly did not weed, each having applied herbicides at the time of land preparation. Weeding tends to be manual (75% of cases), with 41% using herbicides. Herbicide application is with backpack sprayers. Most frequently used herbicides are Gramoxone (16% of rice fields), 2,4-D (15%), Relof (6%), Ronstar (5%) and Roundup (4%). Herbicide dosages vary, with an average of 1.9 l per ha for those that apply Gramoxone, 2.5 l per ha for 2,4-D and 2.5 l per ha for all other products combined.

Farmers tend to apply two weeding operations across the various rice ecologies. Still, the average number of operations is lowest in the lowlands (1.7).

Table 41 Crop management practices reported in selected field by rice ecology (share of surveyed rice fields)

	Upland	Lowland	(Semi-) Irrigated	Overall
Weeding [a]				
- Manual	86%	67%	100%	75%
- Chemical	28%	50%	0%	41%
- None	0%	2%	0%	1%
Av # of weeding operations	2.0 b	1.7 a	2.2 b	1.8 (.00)
Distribution of # of weeding operations:				
- Three weedings	18%	8%	21%	12%
- Two weedings	62%	56%	79%	59%
- One weeding	20%	35%	0%	28%
- None	0%	2%	0%	1%

[a] Combinations of methods reported, so sum does not add up to 100%. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

4.1.6 Fertilizer application

Fertilizer application to rice is relatively widespread (62% of rice fields). There is however a marked difference over rice ecologies – fertilizer application being universal in irrigated rice fields, widespread in rainfed lowland fields and relatively uncommon in upland fields (Table 42 – first layer). The reported fertilizer use in the survey year corresponds closely with the fertilizer utilization index for the same field (Table 42 – last layer; correlation coefficient of 0.62, p.=.00).[13] This suggests that the fertilizer use reported for the selected field in the survey year is not a-typical and relatively constant over time.

Fertilizer is applied manually, typically in a single dose and by broadcasting. Most frequently used fertilizers are NPK (40% of rice fields) and urea (23%), with 5% of rice fields receiving unspecified fertilizer. Fertilizer dosages vary, with an average of 150 kg per ha for those that apply NPK, 69 kg per ha for urea and 103 kg per ha for unspecified fertilizer type.

[13] In turn, the fertilizer user index is associated with the land utilization index (correlation coefficient: 0.38, p.=.00).

Table 42 Crop management practices reported in selected field by rice ecology (share of surveyed rice fields)

	Upland	Lowland	(Semi-) Irrigated	Overall
Fertilizer application	41%	69%	100%	62%
Distribution of # of applications				
- Single dose	36%	62%	79%	55%
- Split dose	5%	7%	21%	7%
- None	59%	32%	0%	38%
Fertilizer utilization index (# of fertilizer applications/ # of crops last 3 years)	0.35 a	0.69 b	1.0 c	0.60 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

4.1.7 Pest control

Half of the rice farmers reported practicing some form of bird control. The prevalent method (39% of surveyed rice fields) is manual bird scaring, whereas 11% reported using bird control structures (notably scarecrows and the use of cassette/video tapes). There is a marked difference between ecologies. Some form of bird control is the rule in upland and irrigated rice fields, but is relatively rare in the lowland rice fields. This is likely to be related to the prevalence of floodplains in lowland rice surveyed – where the substantial rice areas involved are likely to diffuse bird damage incurred and increase the relative cost of bird control.

Control of other pests and diseases was reportedly rare. Only in upland rice – and particularly in Ekiti state – was it relatively common to control other vertebrate pests by setting traps and fencing fields with physical barricades (commonly made of palm fonts).

Table 43 Crop management practices reported in selected field by rice ecology (share of surveyed rice fields)

	Upland	Lowland	(Semi-) Irrigated	Overall
Bird control				
- Manual	51%	29%	79%	39%
- Structure	18%	9%	0%	11%
- None	30%	62%	21%	50%
Other pest management				
- Structure	43%	1%	0%	14%
- None	57%	99%	100%	86%

4.1.8 Harvest and threshing

The harvest and post-harvest operations are manual. Harvesting is commonly done by sickle or knife. The harvest is subsequently threshed and winnowed manually – typically in the field or at the compound. One percent of the rice fields was not harvested because of a tribal crisis in Taraba State.

The average paddy yield for the surveyed field was 1.9 tons per ha. As expected, average yields are highest for irrigated fields – averaging 3.7 tons per ha. However, there was no significant yield difference between the rainfed lowland and upland fields (Table 44). In part, this reflects the overall variability of reported yields, and the skewed distribution of particularly lowland yields. The intercropped fields also yielded 0.4 ton maize per ha on average.

The farmers reported several factors as affecting the 2001 yield in the surveyed fields. The most frequent responses related to the following problem categories:

- fertilizer procurement problems (e.g. access and cost, 27% of 207 farmers. Particularly irrigated rice and to a lesser extent rainfed lowlands);
- weeds/weed control/herbicides (24%, particularly upland and rainfed lowland);
- weather/drought (18%, particularly upland and to a lesser extent rainfed lowland);
- pests & diseases (12%, particularly upland and rainfed lowland).

Despite the reported problems, the reported yields in the survey year are quite normal for the selected field, corresponding on average with 95% of the normal yield (Table 44). The average yields for the same field however vary from 2.8 ton per ha in the best year to 1.2 tons per ha in the worst year. On average, this represents a relative yield range of 145% to 61% (best and worst years respectively, % based on normal year). The ecological yield differences for the survey year also remain for the different types of year: irrigated fields out-yielding the others and no significant difference between upland and lowland yields.

Table 44 Rice yield in selected field by rice ecology

	Upland	Lowland	(Semi-) Irrigated	Overall
Average reported yield				
- paddy (MT paddy/ha)	1.9 a	1.7 a	3.7 b	1.9 (.00)
- maize intercrop (MT maize/ha)	0.44 (n=22)	0.25 (n=9)	-	0.38 (n=31)
Average paddy yield same field (MT paddy/ha, n=239)				
- Normal year	1.9 a	1.9 a	3.6 b	2.0 (.00)
- Best year	2.7 a	2.7 a	5.2 b	2.8 (.00)
- Worst year	1.2 a	1.1 a	2.1 b	1.2 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability of observed difference within rows.

Table 45 presents the same yield data for the selected field across the surveyed states. There is a significant variation over the surveyed states, with average yields being highest in Niger state (3.2 tons per ha) and lowest in Taraba and Benue states (slightly over 1 ton). Ekiti and Kaduna take an intermediate position.[14] The survey averages are clearly influenced by the relative contribution of each ecology. However, the opposite naturally also holds: the ecology averages are influenced by the relative contribution of each state. This is particularly important to underline as certain states are thereby particularly influential for the ecology average. The case of irrigated rice being limited to Niger state is a case in point. However, two other cases are worth underlining here. First, the upland ecology average is to a large extent influenced by Ekiti state, representing approximately half of the upland fields surveyed with an above-average yield level of over two tons.[15] The widespread use of improved varieties – and ITA 150 in particular – by the surveyed upland farmers in Ekiti state is likely to have contributed to the higher yield levels in this state. Second, the lowland ecology average is to a large extent influenced by Taraba and Benue states, the two states representing more than half of the lowland fields surveyed with a below-average yield level of one ton. This interaction between surveyed states and ecology explains the relatively similar average yield levels for upland and lowland fields – whereas one may have expected a yield advantage for lowland fields a priori.

[14] These averages for the surveyed field correspond with the overall yield average at the farm level reported earlier in Table 3. As farmers reported having 2 rice fields on average, this suggests that the surveyed fields were representative of the other rice fields in terms of rice yield.

[15] The upland yield in the other states average 1.6 MT paddy per ha. This average is significantly lower than the upland yields in Ekiti state (2.3 MT, p.:.00), but not significantly different from the overall lowland yield (1.7 MT).

Still it is worth noting that the overall similarity between upland and lowland yields also appears at the individual state level.[16]

Table 45 Rice yield in selected field in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Upland	-	1.7 (±0.8,26)	2.3 (±0.8,34)	2.0 (±1.1,5)	1.2 (±0.6,11)	1.9 (±0.9, 76)
Lowland	3.1 (±1.1,40)	1.5 (±0.9,28)	2.3 (±2.1,2)	1.0 (±0.6,46)	1.3 (±1.1,43)	1.7 (±1.2, 159)
Irrigated	3.7 (±1.2,14)	-	-	-	-	3.7 (±1.2, 14)
Overall	3.2 (±1.2,54)d	1.6 (±0.8,54)b	2.3 (±0.9,36)c	1.1 (±0.7,51)a	1.2 (±1.0,54)a	1.9 (±1.2,249), [.00]

Figures in parenthesis represent ±: standard deviation and n: number of observations. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in '[ ]' in last column is the probability.

4.1.9 Rice cropping calendar

Figure 5 presents an aggregate rice cropping calendar for the selected field across ecologies.[17] The calendar shows that land preparation tends to start earlier in the upland fields than in the other ecologies – in part to secure timely establishment of the crop at the onset of the rains. Indeed, surveyed upland rice fields tend to be established earlier (March to May), rainfed lowlands May to June and irrigated fields from June to August. The rice harvest period in the surveyed fields can run up to December, although the start of the harvest period is ecology dependant – with harvesting of surveyed upland fields starting in August, rainfed lowlands in November and irrigated fields in September (Figure 5). The harvest period is to a large extend determined by factors such as date of crop establishment, varieties used and the rain season. For rainfed lowland, the incidence of flooding may limit access to the field – an issue particularly in some of the flood plains.

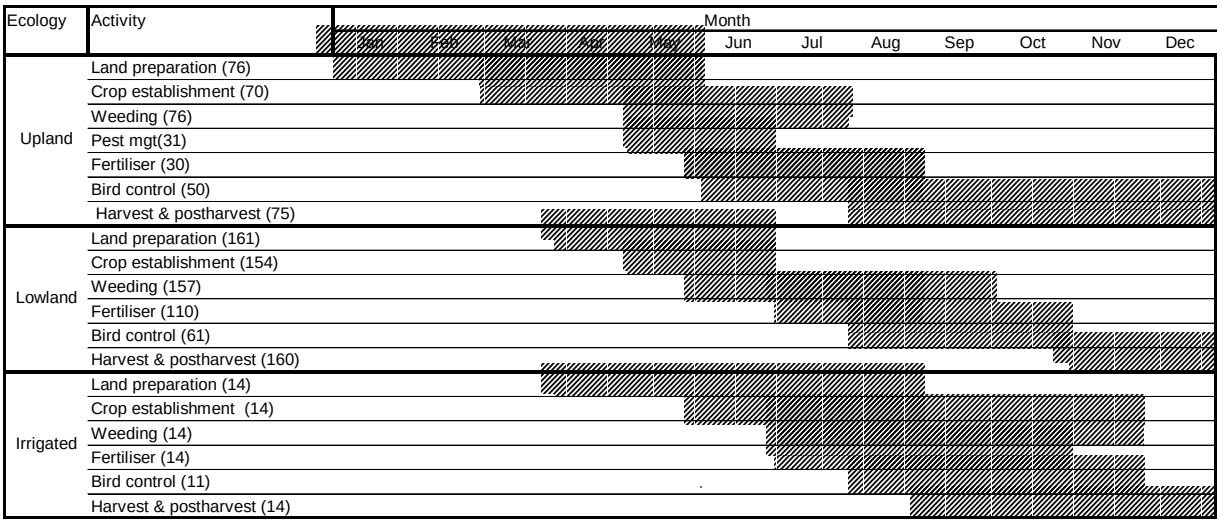

Figure 5 Rice cropping calendar in selected field by ecology

Figures in between brackets represent number of observations per activity. Demarcated are months for which activity was frequently indicated.

[16] Taraba state is the exception – however, the upland average is based on only 5 observations.
[17] For rice cropping calendars disaggregated per state reference is made to Annex 3.

4.2 Gender division of labor

There is a clear gender division of labor in rice production and processing (Table 46). Rice production is clearly the domain of men, whereas rice post-harvest activities are clearly the domain of women. Still, participation rates over the various rice production and processing activities vary. Land preparation is the most male dominated activity. A number of other field activities - crop establishment, weeding, fertilization, harvesting - show a substantial contribution of women – i.e. although men are involved in these operations in 80-90% of the 41 villages, women are also involved in about two-fifths of the villages. Similarly, men are also involved in post-harvest activities in around 30% of the villages, whereas women are involved in 90% of the villages. Bird scaring stands out as an activity dominated by children.

The gender division of labor has important implications for the development of the rice sector – for instance in terms of quality management along the commodity chain. Indeed, the gender division results in different actors being primarily involved in different operations. Therefore, although post-harvest activities may still be performed within the same household, it implies yet another actor who influences the quality of rice.

Table 46 Gender division of labor at village level across survey states (share of villages)

	Participation rate[1]		
Activity	Men	Women	Children
Land preparation	98%	12%	22%
Crop establishment	88%	46%	39%
Weeding	85%	39%	34%
Fertilization (40)	83%	44%	42%
Bird scaring (40)	37%	20%	71%
Other pest control (40)	71%	5%	12%
Harvesting (39)	81%	44%	37%
Threshing & winnowing	34%	88%	20%
Parboiling	24%	90%	7%

[1]Participation rate reflects share of villages reporting participation of the gender in the type of activity. Figures in between brackets represent number of observations if different from 41.

4.3 Typology of rice production systems

The foregoing has shown that rice production practices in Nigeria are varied, and dependant on amongst others rice ecology and geography. But how can we characterize the main current rice production systems? What are the main inter-relationships between ecology and crop management practices? A cluster analysis was applied to a selection of the foregoing variables – particularly field characteristics and crop management practices in the same field - to derive an aggregate typology of rice production systems.[18] Four clusters of rice production systems were retained with characteristics as reported in Table 47.

The first cluster is the largest – with about two-fifths of the surveyed rice fields and thereby can be seen as the most 'typical' rice production system. The other three clusters each represent around a fifth of the surveyed rice fields.

The first cluster can be typified as *traditional extensive lowland* rice production. It is primarily found in waterlogged lowlands with variable flooding levels. Water control is typically non-existent and fields tend to be large (3 ha). The rice crop is either established through broadcasting or drilling,

[18] The variables included are indicated by an '*' in Table 47. The analysis used was a hierarchical cluster analysis with between-group linkages and squared Euclidean distances. All variables were standardized on a 0-1 scale.

transplanting being virtually non-existent. There is an average use of external inputs (fertilizer & herbicides) with an above-average use of traction and improved varieties. Rice yields are however low. Production amounts to some 5 MT paddy per year from about 5 ha, and is primarily for the market.

The second cluster can be typified as *traditional intensified lowland* rice production. It is primarily found in lowlands that are not waterlogged but are subject to limited flooding levels and sometimes have good water control.[19] Fields are small (1 ha) and are used at least annually. Rice is typically transplanted. There is significant use of external inputs (fertilizer & herbicides), but no use of traction. There is limited use of improved varieties and bird scaring is widespread. Rice yields are relatively high. Production amounts to some 6 MT paddy per year from about 2 ha. Although still produced mainly for the market, home consumption levels are significant.

The third cluster can be typified as *modern* rice production. It is found in fields – either upland or lowland – that are not waterlogged and with significant use of external inputs (fertilizer & herbicides) and traction. Rice yields are average and bird scaring rare. Production amounts to some 5 MT paddy per year from about 3 ha.

The fourth cluster can be typified as *traditional upland* rice production. The rice crop is typically established through drilling and intercropping is relatively common. There is very limited use of external inputs (fertilizer & herbicides) and traction, with significant fallowing (i.e. low land utilization index). Use of improved varieties and bird scaring is common. Rice yields are average. Production amounts to some 3 MT paddy per year from about 2 ha, and is primarily for the market.

Again, it is somewhat problematic to capture the various characteristics of each production cluster in a simple label. Still, with the risk of being incomplete and over-generalizing, the four rice production clusters can be labeled:

1. ‘traditional extensive lowland’;
2. ‘traditional intensified lowland’;
3. ‘modern’ (both lowland and upland);
4. ‘traditional upland’.

The use of ‘traditional’ and ‘modern’ mainly relates to the relative intensity of external input use. The use of ‘extensive’ and ‘intensive’ mainly relates to the relative intensity of land use and can be interpreted as a reflection of: (i) the relative scarcity of land vis-à-vis labor (‘extensive’ thereby being more labor limited [with respect to land], and ‘intensive’ being more land limited [with respect to labor]); and (ii) hydrology (‘extensive’ typically having limited water control being waterlogged and/or subject to natural flooding; ‘intensive’ typically having better water control).

The rice production clusters reflect the interaction between technology and topography in rice production at the time of the survey. However, it is useful to see this typology in a dynamic perspective. First, as technology use itself is not static. Mention was already made of the need to interpret ‘traditional’ and ‘modern’ in relative terms (e.g. external input use is less widespread in the ‘traditional’ systems, but nonetheless the majority of ‘traditional’ lowland rice production systems do rely on fertilizer use). Furthermore, what is modern now, may become traditional in the near future when it becomes established practice (e.g. use of improved varieties and fertilizer). Second, the clusters themselves can be viewed on a temporal continuum. Most obvious perhaps is the modern rice production system (cluster 3), which seems to have evolved from more traditional lowland (cluster 2) and upland (cluster 4) production systems. The two traditional lowland production systems seem to have evolved differently over time reflecting the relative resource (land and labor) scarcity as well as hydrological considerations. The two traditional lowland production systems indeed show a marked difference in terms of the incidence of waterlogging and flooding, and this has direct implications for potential water control, field accessibility and technology use.

[19] All irrigated fields with only incomplete water control were categorized in cluster 1.

Table 47 Selected characteristics of rice production clusters

Indicator \ Cluster	Cluster 1 (n=101)	Cluster 2 (n=44)	Cluster 3 (n=38)	Cluster 4 (n=63)	Overall (n=246)
Plot characteristics					
- Plot size (ha) *	3.1 c	1.1 a	2.2 b	1.5 ab	2.2 (.00)
- Upland *	0%	0%	42%	95%	31%
- Maximum flooding depth (m) *	0.7 b	0.5 b	0.2 a	0.0 a	0.4 (.00)
- Waterlogged *	93%	5%	0%	2%	39%
- Irrigated *	3%	25%	0%	0%	6%
Crop establishment					
- Broadcast*	51%	0%	24%	6%	26%
- Transplant*	1%	84%	5%	0%	16%
- Intercropping *	4%	0%	5%	38%	12%
Technology use survey year in plot					
- Use of fertilizer*	64%	84%	87%	29%	62%
- Use of herbicide*	55%	68%	79%	16%	51%
- Use of traction (tractor, animal)*	37%	0%	74%	3%	27%
- Use of improved varieties *	77%	34%	68%	67%	65%
- Use of bird scaring	23%	73%	5%	62%	39%
Field level					
- Plot yield (MT paddy per ha)*	1.4 a	3.1 c	1.9 b	1.9 b	1.9 (.00)
- Field fertilization index use index	0.64 b	0.92 c	0.68 b	0.29 a	0.60 (.00)
- Land utilization index *	0.92 b	1.04 c	0.93 b	0.79 a	0.91 (.00)
- Use of paid labor in plot *	90%	89%	97%	97%	93%
Farm level					
- Rice area (ha per year)	4.7 c	2.1 a	3.2 b	1.8 a	3.2 (.00)
- Rice production (MT per year) *	5.2 b	5.9 b	4.8 b	2.8 a	4.6 (.02)
- Rice commercialization (% of total production)*	82% c	70% a	77% b	82% c	79% (.00)

* Standardized variables included in cluster analysis. % refer to share of cases (i.e. surveyed fields) within column, unless otherwise indicated. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The rice production clusters are linked to the geographic distribution of the rice fields (Figure 6). The first and largest cluster - 'traditional extensive lowland rice production' - is representative of the rice production systems in the lowlands of Benue and Taraba state, and a subset of farmers from Niger state. The second cluster ('traditional intensified lowland rice production') is representative of lowland systems in Niger state. The third cluster ('modern rice production – both lowland and upland') includes subsets of farmers from primarily Kaduna and Taraba state. The fourth cluster ('traditional upland rice production') is representative of upland rice in Ekiti and Kaduna state.

The present cluster analysis includes primarily field characteristics and crop management practices in the same field, with only selected rice indicators at the farm level (namely annual rice production and produce share marketed – annual rice area being closely related to plot size). In an earlier cluster analysis we included characteristics of the rice producing household (section 3.5). Contrasting the 'producer clusters' (i.e. household characteristics) with the 'production clusters' (i.e. production systems) allows us to assess the interlinkages between the two (Figure 7).

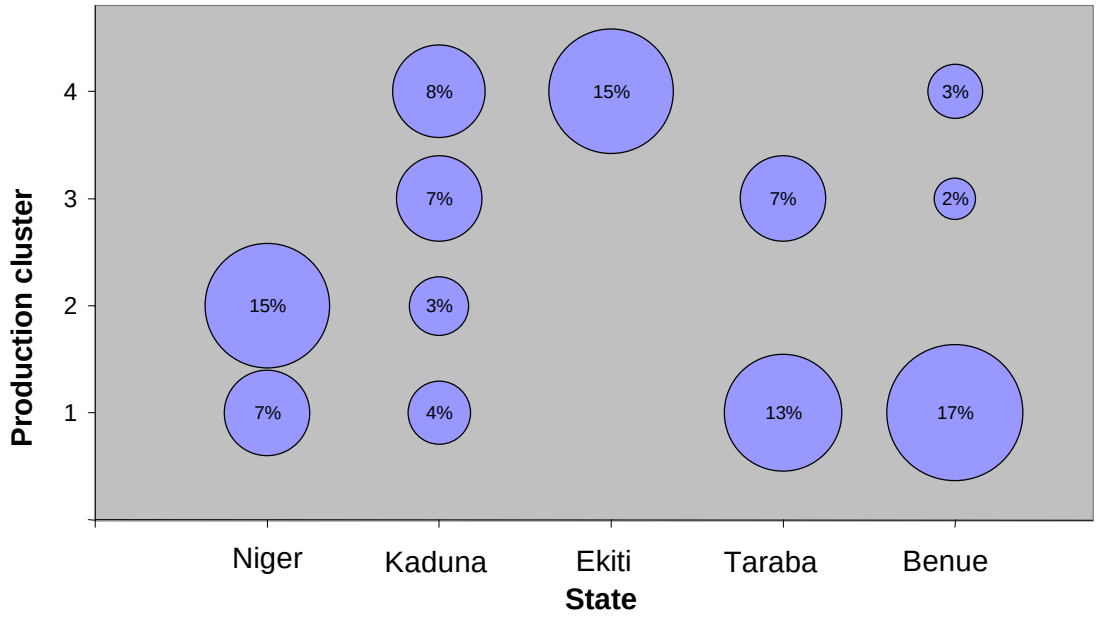

Figure 6 Distribution of rice production clusters in survey states (share of households, n=246)

The production cluster one - 'traditional extensive lowland rice production' - is primarily the domain of rice producer clusters one ('medium-scale' diversified farmers – the combination of production and producer cluster representing 22% of all surveyed households) and two ('resource-rich & large-scale' farmers – 15%). Production cluster 2 ('traditional intensified lowland rice production') is primarily the domain of another subset of rice producer cluster one ('medium-scale' diversified farmers – 15%). Above we have seen that production cluster 2 is primarily located in Niger State – suggesting that for this cluster historical factors (eg rice growing tradition) may be more determinant for technology use than the household resource base per se. Production cluster 4 ('traditional upland rice production') is primarily the domain of rice producer cluster 3 ('small-scale' upland farmers – 13%) and yet another subset of rice producer cluster one ('medium-scale' diversified farmers – 10%). Production cluster 3 ('modern rice production' - both lowland and upland) is least clearly linked to any of the producer clusters – the largest being producer cluster 2 ('resource-rich & large-scale' farmers – 7%).

The foregoing discussion allows us to draw some tentative conclusions. First, that the producer and production clusters are related. Indeed, the more common combinations of producer and production clusters discussed above encompasses 82% of all surveyed fields/households. Second, that although related, each is an imperfect proxy for the other. In other words, household characteristics influence the choice of production practices, but households with similar characteristics may still opt for different production practices – amongst others dependant on field characteristics and preferences.

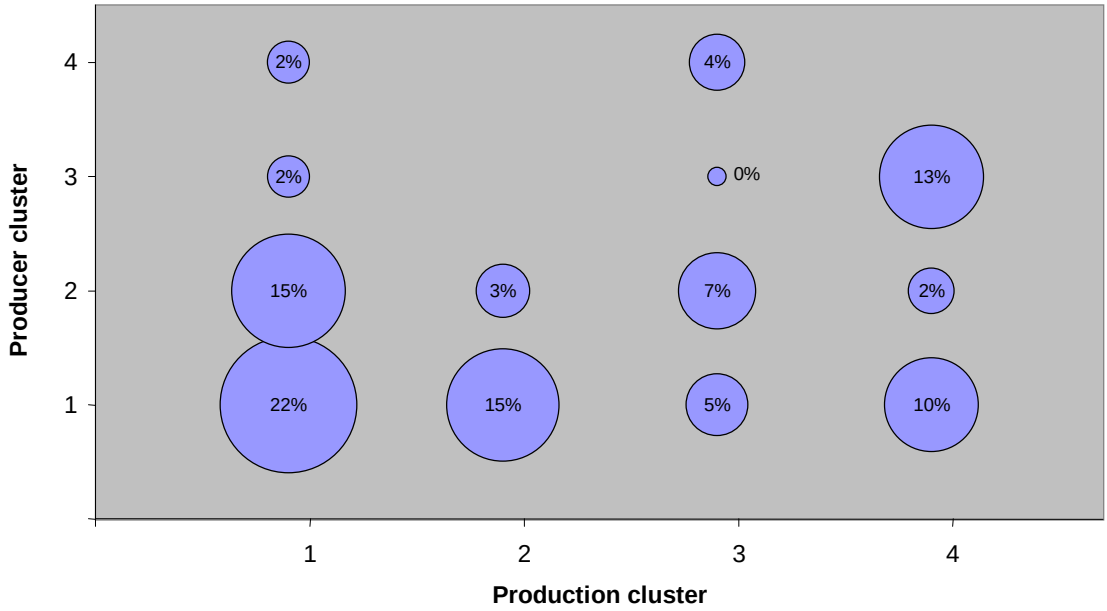

Figure 7 Relationship between rice producer clusters (based on household characteristics) and rice production clusters (based on field characteristics and practices, share of households, n=244)

4.4 Technological change

The foregoing sections looked at the current production practices in the surveyed field. This section would like to briefly look into some of the underlying technological changes.

4.4.1 Institutions and technological change

The main changes in rice production practices over the last decade were inventoried at the village level. The most frequent response categories were: (i) no change (34% of villages); (ii) mechanization (20%); (iii) herbicide use (17%); (iv) varieties (15%); (v) fertilizer use (10%); (vi) crop management (10%); (vii) crop establishment (10%); (viii) change in ecology (7%) and (ix) de-mechanization (7%). The fact that one-third of the villages reported no changes suggests that rice production practices are relatively well established in those villages. Indeed, the no-change category is relatively more common in villages were rice is considered an indigenous crop. Still, two-thirds of the villages reported production practice changes – suggesting adaptations of the rice producers to either adapt to a changing environment or make better use of technological opportunities.

About half the rice producing farm households are member of an agricultural organization (Table 48). However, the term comprises miscellaneous types of organizations with varying objectives: (i) Cooperative (20% of reported agricultural organizations); (ii) Input access (19%); (iii) Loan access (15%); (iv) Labor access (16%); (v) Agricultural development (14%); (vi) Community development (14%); (vii) Political (3%). Most of these organizations are at the community/village level. The relative organizational emphasis on the facilitation of access to resources and markets is noteworthy. Indeed, the village survey also highlighted that 17% of the villages had some village level organization to buy inputs (similar to the organizational membership at the farm level), 15% to sell produce and 24% to access other services.

Mass media such as radio and TV are important sources of agricultural information, reported by three-quarters of rice producing households. Agricultural extension agents are also an important source of agricultural information, reported by nearly three-fifths of rice producing households. In part this is a reflection of the presence of agric extension staff (any level) in 44% of the surveyed villages. A considerable share of the rice farm households (68%) reported having had contact with an agricultural agent/extension worker – most commonly in relation to general agric information, fertilizer and seeds/variety. Other farmers were reported as sources of agricultural information by one-quarter of rice producing households (Table 48).

Table 48 Agricultural organization and information sources at farm level in survey states (share of households)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Member of agricultural organization	83%	43%	39%	78%	15%	53% (.00)
Agric. information source:						
- radio/TV	71%	89%	87%	90%	34%	74% (.00)
- ag. extension	40%	76%	46%	45%	66%	56% (.00)
- other farmers	21%	44%	9%	29%	19%	26% (.00)

4.4.2 Rice varietal use

Rice farmers were asked to list the rice varieties they used and the rice varieties they had abandoned. In total 140 different variety names were reported across the five surveyed states.[20] Of the 140 varieties, 96 varieties were still in use whereas 44 had been completely abandoned amongst the survey farmers. However, an additional 41 varieties had been partially abandoned – i.e. were reportedly abandoned by some surveyed farmers, but still in use by others. Consequently, in total 85 varieties were reportedly abandoned (44 completely; 41 partially).

The farmers were also asked to classify the variety as either improved or traditional. Of the 140 reported varieties, the large majority (86 varieties) was considered as 'traditional' by farmers, whereas 40 varieties were considered 'improved'. Farmers were ambivalent about 11 varieties – some considering these varieties as 'traditional' and others as 'improved' – whereas 3 varieties were unspecified. The farmer classification of varieties as 'traditional' or 'improved' is indicative – indeed, 'improved' varieties can occasionally become to be considered as 'traditional' by farmers after prolonged utilization. Alternatively, farmers may not know the original source of a variety – especially in the case the seed spread through informal channels.

Rice farmers tend to use an average of two rice varieties – a figure which is remarkably constant across the various states except for Ekiti state, were farmers tend to use only one (Table 49). In terms of the type of varieties used, farmers reported common use of both traditional (56%) and improved varieties (65%) – i.e. 44% use 'improved' varieties only, 35% 'traditional' only and 20% both 'improved' and 'traditional'. However, there is again a significant variation across states. In Benue and Ekiti state farmers reported primarily the use of 'improved' varieties, whereas in the other states the use of 'traditional' varieties was predominant. In Ekiti state early maturing ITA 150 was clearly predominant – reported by 83% of surveyed farmers, typically as the sole variety in use. In Benue state the improved varieties reported by farmers were more heterogeneous, in part a reflection of the

[20] In total 171 different names were originally reported. These were subsequently regrouped into 140 names, taking into account reported correspondences between variety names and grouping those names that appeared to be very similar (i.e. most likely referring to the same variety). However, the number of variety names remains of indicative value only as some names may still refer to the same variety or similar names may actually refer to different varieties. This is particularly an issue for some of the local names which differ amongst states.

2.3 varieties being used per household. The predominant varieties in use in Benue state being 'Turu II/Turn II' (26 cases), 'China' (24 cases), 'Mass/Mars' (13 cases), 'Canada' (12 cases) and 'Zomuje' (10). However, it is worth noting that whereas in Benue State, farmers considered all of these to be 'improved' varieties, farmers in other states did not necessarily concur. For instance, in other states farmers were ambivalent about both 'China' and 'Mass/Mars', with an overall majority classifying these two long-in-use varieties as 'traditional'.[21] This reiterates the need to interpret the farmer varietal classification as 'traditional' or 'improved' with care, particularly for those varietal names where the improved nature of the variety is not particularly obvious.

Rice farmers reportedly abandoned on average one rice variety (Table 49). The type of varieties abandoned tend to be 'traditional' varieties.[22] The mains reasons for abandoning varieties (251 responses) included: (i) yield (28% of responses); (ii) length of cycle (17%); (iii) Marketing/price issues (14%); and (iv) not adapted (9%). The yield-increasing potential of improved varieties is well-known. However, the second and third reasons are interesting to note. Improved varieties can offer a potential reduction in the crop cycle length. The farmer-estimated average cycle length of the 'improved' varieties (under 4 months) indeed is significantly shorter than the length for the 'traditional' varieties (5 months - Table 49). Indeed, the reported cycle length for varieties in use (4.4 months) is significantly shorter than for the abandoned varieties (4.7 months, p.:.03). The importance of marketing/price issues as reason for abandoning corresponds with rice being a crop produced for the market – whereby farmers abandon varieties which are difficult to sell and/or tend to obtain a lower price.

Table 49 Rice varietal use indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
# of varieties in use (average)	2.3 b	2.3 b	1.1 a	2.3 b	2.3 b	2.1 (.00)
Type [a] of varieties in use (share of households, n = 251)						
- Traditional	82%	91%	8%	82%	0%	56%
- Improved	59%	13%	97%	65%	100%	65%
# of varieties abandoned (average)	0.5 a	1.2 c	0.6 a	1.6 d	0.9 b	1.0 (.00)
Type [a] of varieties abandoned (share of households, n =175)						
- Traditional	77%	100%	100%	80%	29%	78%
- Improved	23%	2%	5%	41%	80%	31%
Reported cycle length (average months, n = 699)	4.5 c	5.6 d	3.0 a	4.1 b	3.9 b	4.5 (.00)
- Traditional type [a] (n = 417)	4.8	5.7	-	4.2	4.4	5.0
- Improved type [a] (n = 282)	4.0**	4.3**	3.0	3.7*	3.8*	3.8**

[a] Based on farmer classification. Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability. **, *: improved type differs significantly (.00 level and .05 level respectively) from traditional type, within column comparison.

Farmers reported a variety of sources as their original seed source, including: (i) Market (31%); (ii) A specific geographic location (24%); (iii) Government (e.g. extension, research - 24%); (iv)

[21] In case of 'China' 47 cases classified it as 'traditional', 27 cases as 'improved'. For 'Mass/Mars' the respective figures were 16 vs. 14 cases respectively.

[22] Again Benue State stands out in terms of reporting 'improved' varieties – this time as abandoned. This could be explained by a number of factors. First, in Benue State farmers and/or enumerators may overzealously classify varieties as 'improved' (at least compared to the other states). Second, rice production is less traditional in Benue state, at least in the surveyed areas, and hence most rice varieties tend to have come from outside and are considered as 'improved'. At this stage we can not ascertain which factor actually explains the prevalence of 'improved' varieties in the Benue case, but a combination of the two-aforementioned factors seems likely.

informal sources (e.g. other farmers; inherited, from within village - 23%). Based on these response categories it is not possible to distinguish 'certified' from 'uncertified' seed sources. Still, it seems safe to assume that uncertified seed sources predominate. At the village level, 44% of villages reported access to improved rice seed. And in any event, the re-use of seed kept from the last harvest is near universal.

4.4.3 External input use

In section 4.1 we reviewed the rice production practices in the selected field. In general, we expect the crop management practices in the selected field to be representative for all the rice fields of the rice farmer. However, this is not necessarily so and the rice farmer may apply different management practices to other rice fields. Similarly, the rice farmer may apply different technologies to other non-rice crops. The present section looks at three external input technologies in particular – fertilizer, herbicide and mechanization. All have significant implications for intensification of rice production.

Table 50 compares the reported external input use in the selected rice field with the use rate for the farm as a whole. By definition, all farmers using an external input for the selected rice field will also use it for their farm as a whole (of which the rice field is part). Still, it appears that a significant share of rice farmers although reportedly not using the external input in the selected rice field do use it in some other field (rice or non-rice). In addition, the table also includes the reported input access at the village level. Interestingly, reported village level access can be seen as a reasonable proxy for the actual use rate at the farm level.

Table 50 External input indicators at farm and village level in survey states

	Fertilizer	Herbicide	Tractor
Reported use in selected rice field (% fields, n=252)	62%	52%	26%
Reported use for whole farm (% farms, n=252)	76%	67%	33%
Reported village level access (% villages, n=41)	80%	66%	44%

Of the three technologies, fertilizer use is the widest spread. However, the spread is uneven over the surveyed states – with near universal fertilizer use amongst rice producing households in Niger and Kaduna state whereas use is virtually absent in Ekiti state (Table 51). Fertilizer use is in part related to ecology, with Ekiti being mainly upland. Current use rates also are related to the year of first use: adoption of fertilizer reportedly started earlier amongst rice producing households in Niger and Kaduna state (mid-1980s) and much more recently in Ekiti state (on average 1992 for users). Taraba and Benue state take an intermediate position. This seems to suggest that the lower fertilizer use rates are in part due to a later start of fertilizer diffusion. The lower current use rates however also appear to be related to dis-adoption – as 10% of the surveyed farmers stopped using fertilizer and dis-adoption rates are approximately a fifth in Benue and Ekiti state (Table 51). The reasons for dis-adoption vary for these two states. In Benue state the main reason for stopping use is the fertilizer price. In Ekiti state the main reason for non-use (71% of non-users, i.e. both those that never used or stopped using) was that fertilizer reportedly is not available locally. In part this is likely related to the source of fertilizer. In all states except Ekiti state, the market was cited as the main source for fertilizer procurement. In Ekiti state farmers cited the government as the main source.

Table 51 Fertilizer use indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Fertilizer use (share of households)						
- Never used	2%	0%	67%	11%	7%	14%
- Only used before	0%	2%	22%	9%	19%	10%
- Continues to use	98%	98%	11%	80%	74%	76%
Year of first use (average)	1983 a	1986 ab	1992 c	1987 b	1988 b	1986 (.01)

Of the three technologies, herbicide use is the second widest spread. Again, the spread is uneven over the surveyed states – with significant herbicide use amongst rice producing households in all states except in Ekiti state (Table 52). There is no clear relationship between current use rates and the year of first use – although adoption again reportedly started earlier amongst rice producing households in Niger and Kaduna state. Herbicide use seems to have spread rapidly in Taraba state – from a relatively recent introduction (mid-90s) to the reportedly highest current average use rate. Herbicide adoption does seem to lag behind fertilizer – both in terms of extent and start of use. Herbicide dis-adoption (4%) also is less common than for fertilizer (Table 51). The reasons for non-use of herbicides are primarily linked to non-availability of herbicides and secondly to their price. The market is the main source for herbicide procurement.

Table 52 Herbicide use indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Herbicide use (share of households)						
- Never used	20%	26%	78%	17%	20%	29%
- Only used before	4%	2%	6%	0%	9%	4%
- Continues to use	76%	72%	17%	83%	70%	67%
Year of first use (average)	1988 a	1990 ab	1996 c	1994 c	1992 bc	1992 (.00)

Mechanization is the least wide spread of the three technologies – although still a third of the surveyed farmers reportedly continued to use tractors. Two issues stand out in terms of tractor use. First, the marked concentration of tractor use in Taraba state. This, in combination with the extensive use of herbicides in this state, seems to reflect a strategy of labor saving-saving technology in this remote state to address labor-constraints that limit the extent floodplains can be cultivated. Second, the discontinuation of tractor use is relatively common – the more so if we compare against current users (Table 53). In part, this reflects the consequences of structural adjustment and the retreat of the state. Indeed, the market and the government were the main providers of traction services to current and former users, whereas now the market tends to be the main if not sole provider. The main reason for not using tractors are that they are not available locally and their price.

Table 53 Tractor use indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Tractor use (share of households)						
- Never used	76%	69%	89%	9%	52%	57%
- Only used before	7%	4%	6%	9%	26%	11%
- Continues to use	17%	28%	6%	82%	22%	33%

4.5 Reported production problems

Farmers were asked for their main rice production problems. On average, farmers enlisted 3.4 production problems. These open responses were subsequently grouped into a number of response categories of which the main 16 categories are presented in Table 54. Two observations are in order. First, that some problems are of local importance whereas others cut across several states. Second, that some problem categories are clearly related. We opted here not to generalize too much in order to still allow for some insight in the underlying factors – thereby retaining separate categories where the data allowed and where it was considered useful.

Table 54 Production problems reported at farm level in survey states (share of households reporting, multiple responses per household, open responses grouped)

State / Problem category	Niger (n=53)	Kaduna (n=54)	Ekiti (n=36)	Taraba (n=54)	Benue (n=54)	Overall (n=251)
Fertilizer access/cost	76%	65%	25%	57%	82%	63%
Funds/capital/credit access/cost	55%	35%	72%	69%	57%	57%
Mechanization access/cost	81%	33%	0%	72%	24%	45%
Herbicides access/cost	45%	0%	0%	39%	54%	30%
Weeds incidence/control	4%	32%	28%	13%	35%	22%
Labor access/cost	2%	13%	58%	9%	24%	19%
Pests & diseases incidence/control[23]	4%	15%	28%	24%	13%	16%
Access/cost of inputs in general	13%	13%	19%	24%	7%	15%
Birds/rodents incidence/control	4%	0%	81%	0%	7%	14%
Weather problems	9%	6%	39%	4%	9%	12%
Accessibility problems	13%	7%	14%	7%	7%	10%
Produce marketing problems	2%	9%	6%	13%	2%	6%
Flooding problems (incidence; uncertainty; excess)	9%	2%	0%	13%	2%	6%
Soil problems	4%	2%	8%	4%	7%	5%
Seed access/cost	0%	11%	0%	9%	2%	5%

Underlined are the 4 main response categories within the state.

The most widely reported production problems clearly emphasize external input use. First, in terms of access to and the cost of external inputs as fertilizer (63%), mechanization (45%) and herbicides (30%). Second, in terms of the possibilities and cost of financing such external use – i.e. the access to and the cost of funds, capital and credit (57%). It is interesting to note that the top three problem categories in each state except Ekiti state always pertain to these four problem categories. Except for mechanization, this reflects current use of fertilizer and herbicides by rice producing farm households and the corresponding need to finance production costs.

It is interesting to note that rice farmers in Ekiti state clearly signal financing constraints as a major problem – and this despite limited external input use. The financing constraint is therefore most likely a reflection of the use of day laborers. Indeed, Ekiti state stands out as the sole surveyed state where access to and cost of labor was frequently perceived as one of the main production problems. This seems to imply that there is substantial scope for increased herbicide use for rice farmers in Ekiti state so as to address the labor constraint of weeding – one of the major labor demanding activities. Ekiti state also stand out from the other states in terms of their other main problems. The incidence and control of birds and rodents is the most widely cited problem in Ekiti state – a reflection of the forest ecology and implying widespread use of bird scaring and other pest control measures such as fencing fields and trapping. Weather problems were amongst the top four problem categories in Ekiti state – a reflection of the upland ecology and the corresponding weather risk.

[23] Includes pests in general, but mainly non-vertebrate, as birds and rodents often reported separately.

Incidence and control of biotic stresses such as weeds (22%), pests and diseases (16%) and birds and rodents (14%) were also frequently reported as a problem. Still, it should be noted that responses particularly pertaining to the access to and cost of herbicides and pesticides were grouped in a separate problem category. A-biotic stresses were variously reported as production problems – the most frequently cited categories including weather (12%), flooding problems (6%) and soil problems (5%).

'Accessibility problems' and 'produce marketing problems' were cited as production problems and as such included here. However, a separate table (Table 67) specifically addresses marketing problems and these issues will be elaborated there. Still, it should be realized that accessibility not only affects produce marketing but also has implications for external input use and crop management – e.g. in terms of procuring external inputs and the ease of accessing the field during the crop cycle. Indeed, on average the fields were located at 2.5 km from the house (n=246). Irrigated fields were significantly further a field than upland and lowland fields – on average 4.7 km vs. 2.4 km.

Finally, only 5% of the surveyed farmers mentioned access to and cost of seed as one of their main production problems. This is most likely a reflection of the widespread practice of keeping seed from the previous harvest – which typically implies widespread availability of seed within rice producing communities and a relatively intangible in-kind cost. Still, it seems there is substantial scope for varietal renewal and further introduction of improved rice varieties.

Farmers were also asked to prioritize their main rice production problems to come up with the most severe. Figure 8 presents these priority production problems. For comparison purposes the same figure includes the overall category, which corresponds with Table 54. As one would expect, the incidence of each problem category is now less frequent.[24] There is also some realigning of problem categories, although the overall tendencies remain similar. Financing becomes the number one problem (35%), followed by the various external input use categories (fertilizer - 19%; mechanization – 10% and external inputs in general – 9%) and the incidence and control of weeds (9%).

4.6 Discussion

The present chapter has shown that rice production practices are variously related to the ecology and location of rice production and household characteristics of rice producers. External input use for rice production is relatively widespread and tends to emphasize fertilizer (62%) and herbicides (52%). Up to a quarter of rice producers reportedly used tractors for land preparation. The relatively widespread use rates are higher than initially expected – especially as prior to this study it was often asserted that external inputs were either not available to farmers (e.g. when fertilizers were heavily subsidized) or simply too expensive (e.g. after structural adjustment and liberalization).

Despite relatively widespread use of external inputs, two issues stand out. First, the most widely reported production problems clearly emphasize external input use - in terms of access to and the cost of external inputs and the possibilities and cost of financing such external use. Second, rice yields remain relatively low – averaging 1.9 MT of paddy per ha, but being significantly higher in fields with partial or full water control. In part the low yields are a reflection of varietal use. Rice producers tend to use two rice varieties, comprising both 'traditional' and 'improved' varieties. There indeed is substantial scope for increasing the use of 'improved' varieties – as is shown by the case of Ekiti state, where farmers tend to use improved varieties, and even with limited external input use, obtain above average yields.

[24] More or less 30% of the earlier incidence, a reflection of the reduction of 3.4 problems per household to one.

Rice production is mainly a men's enterprise, whereas rice processing clearly is the domain of women. The subsequent chapter will characterize the rice post-production practices of rice producing households in term of utilization, processing and marketing.

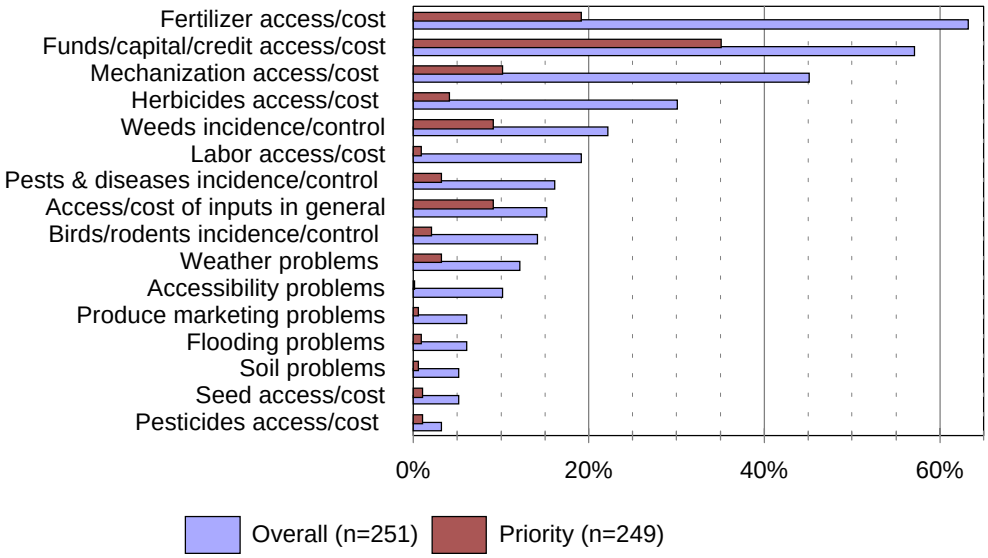

Figure 8 Production problems reported at farm level by priority in survey states (share of households reporting)

'Overall' category implies problem being mentioned amongst main problems (multiple responses per household, open responses grouped); 'priority' category implies it was singled out as the most severe problem

5 Rice utilization, processing & marketing

The present chapter characterizes rice post-harvest issues so as to answer a number of questions. For instance, what share of rice produced is marketed and consumed? What processing and marketing channels are used? What are the marketing problems farmers are actually facing? The chapter first quantifies rice utilization – with particular emphasis on commercialization and consumption. It subsequently describes first the rice processing strategies and the main rice transformations – rice parboiling and milling – and second, the rice marketing and storage practices. The chapter ends with a description of marketing problems as perceived by the farmers – followed by a brief discussion/summary.

5.1 Rice utilization

Rice is primarily produced for the market: on average, 79% of the total annual paddy production is marketed by the rice producing household. This clear market orientation is consistent across the surveyed states, although the actual marketed share varies somewhat (Table 55). The remainder of the paddy produced is destined for consumption (10%), seed (7%) and other uses (4%).

Table 55 Use of paddy production at farm level in survey states (average % of total farm produce by destination)

State / Produce use	Niger	Kaduna	Ekiti	Taraba (52)	Benue	Overall (250)
% for commercialization	70% a	75% b	85% d	80% c	86% d	79% (.00)
% for consumption	19% d	13% c	9% b	5% a	5% a	10% (.00)
% for seed	5% a	8% b	5% a	8% b	9% b	7% (.00)
% for other uses	6% c	4% b	0% a	7% c	1% a	4% (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The highest shares of produce devoted to consumption are reported for Niger and Kaduna state, and to a lesser degree Ekiti state – reflecting underlying consumption patterns. Indeed, 18% of rice producing households reportedly did not consume the rice they produced – with these cases concentrated in Benue state and to a lesser degree Taraba state (Table 56 – 1st layer).[25] On average, rice producing households have an imputed consumption rate of 31 kg of rice per capita – remarkably similar to the national average. This average however masks significant differences between the survey states – with an average consumption rate of 78 kg in Niger state and only 7 kg in Benue state (Table 56 – 2nd layer). The high consumption levels in Niger state link back to the long history of rice production and consumption in Niger state.

Half the rice producing households reported the practice of giving away some of their produce – a practice that is closely related to the local consumption of rice (Table 62 – 3rd layer). Gifts of rice average 375 kg and are typically in the form of fresh paddy. Gifts are typically given to other farmers (60% of cases giving) and to fulfill religious/social obligations (25% of cases giving). It is relatively uncommon for rice producing households to complement their own rice production with rice from other sources: only 3 cases reported buying rice throughout the year and 5 cases reported receiving rice as gift.

[25] With the exception of one case, these households also did not report rice purchases or rice gifts received, suggesting they do not consume rice.

Table 56 Selected rice consumption indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Consume part of own rice (share of hh)	100%	100%	100%	73%	44%	82%
Imputed consumption rate own rice (kg rice per capita per year) [1]	78 c	21 b	25 b	19 b	7 a	31 (.00)
Give rice to others (share of hh)	76%	65%	58%	44%	11%	50%

[1] Based on paddy produced kept for consumption, 0.58 transformation rate to rice and weighted household composition (applying 50% weight to children)

5.2 Rice processing

Paddy is the output of rice production at the field after harvesting, threshing and winnowing. This paddy subsequently needs to be processed to obtain consumable rice. In Nigeria, rice is consumed as parboiled rice and processing therefore implies two distinct processes: parboiling and milling. Such processing has important implications for the quality of the end product. Therefore, it is important to know what processes are being used and who is involved in the various transformations.

5.2.1 Rice processing strategies

The majority (90%) of the rice producing households also process paddy by parboiling and/or milling. However, processing may be done to prepare the paddy for home-consumption and/or to add value for subsequent sale. Consequently, the mere fact of processing paddy does not necessarily imply that the household processes all of its paddy production. Indeed, different processing strategies co-exist (Table 57). The most common strategy followed by just over half the households is that processing is only done for home-consumption, whereby marketed produce is sold as fresh paddy. Another strategy followed by about a quarter of the rice producing households is to process both for consumption and sale. A tenth of the rice producing households process only for subsequent sale – reflecting a pure market orientation with no home consumption. Another tenth does not process at all – i.e. nor for consumption nor for sale – reflecting that all paddy is marketed in its fresh form. Consequently, 81% of rice producing households process paddy for home-consumption[26], and only 34% for subsequent sale. This implies that most of the processing by rice producing households is to prepare the paddy for home-consumption. This also implies that most of the marketed produce enters the market as unprocessed fresh paddy – and is subsequently processed by another actor in the rice commodity chain.

Parboiling and milling are two separate processes that are often performed by different actors, as we will see below. Still, it is noteworthy that in many respects, the incidence and purpose of each processing activity tends to resemble the other. That is, those households that parboil their paddy also tend to mill it. Similarly, those that parboil for subsequent sale (or consumption) also tend to mill for sale (or consumption). Therefore, although parboiling and milling are two separate processes, the decision to parboil and mill is integrated. That is, there is little trade in intermediate products such as parboiled paddy. Farm households therefore tend to market their produce either fully processed (i.e. milled parboiled rice) or unprocessed (i.e. fresh paddy) – with the latter being the prevalent practice.

[26] The 81% reported here corresponds with the 82% of the households that consume part of their produce. The difference is due to the current number being based on a subset (n=235) of the overall sample.

Table 57 Processing strategies at farm level

		Process for sale		
		No	Yes	Overall
Process for consumption	No	10%	9%	19%
	Yes	55%	26%	81%
Overall		66%	34%	100% (n=235)

The processing strategy followed by rice producing households varies over the surveyed states (Table 58). In Niger and Kaduna state farmers primarily process for home consumption purposes, and in Ekiti state for both sale and consumption purposes. The 'no-processing strategy' and the 'processing-only-for-sale strategy' are only found in Taraba and Benue states, a direct reflection of the more limited home consumption.

Table 58 Processing strategy at farm level in survey states (share of households)

State / Strategy	Niger	Kaduna	Ekiti	Taraba	Benue	Overall (n=235)
- No processing	0%	0%	0%	33%	22%	10%
- Processing for consumption only	100%	78%	22%	20%	35%	55%
- Processing for sale only	0%	0%	0%	5%	37%	9%
- Processing for consumption and sale	0%	22%	78%	43%	6%	26%

5.2.2 Parboiling

Parboiling paddy in Nigeria is a 'cottage industry'. Parboiling paddy by rice producing households is typically done by the household itself (86% of parboiling households, Table 59 – 1st layer). The remaining households contract the parboiling service from primarily private parboilers, and to a lesser extent private millers with parboiling facilities.[27] Those households that parboil at home, primarily (91% of parboiling households, Table 59 – 2nd layer) do so only for themselves and do not parboil for others (i.e. do not contract out their parboiling services). On average, parboiling households have a parboiling capacity of 200 kg of paddy – comprising 2.4 parboiling pots with 87 kg per pot. The parboiling capacity is significantly above average in Niger state, and substantially lower in the other states – a reflection of a significant variation in number of pots per household and corresponding pot sizes (Table 59 – 2nd layer).

[27] In terms of rice processing, rice mills tend to mill only – and only in two villages (5%) do rice millers also parboil.

Table 59 Selected parboiling indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Location of parboiling (n=206, share parboilers)						
- At home	89%	78%	97%	96%	80%	86%
- Private parboiler/mill	13%	22%	3%	8%	21%	15%
For those parboiling at home						
- parboil for others (share home parboilers, n=164)	0%	23%	3%	14%	8%	9%
- av. # pots/drums per hh	2.3 a	3.0 b	1.7 a	3.1 b	1.8 a	2.4 (.00)
- average drum capacity (kg per drum)	140 e	43 a	89 c	57 b	108 d	87 (.00)
- average total parboiling capacity (kg)	310 b	170 a	140 a	140 a	210 a	200 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

5.2.3 Rice milling

Milling is also a 'cottage industry', primarily done in small-scale mills, although occasionally (10% of those that mill) a share of the produce may also be milled by traditional hand-pounding. Such hand pounding is typically done for limited quantities for own consumption. The reliance on third parties to provide the milling service makes for a significant contrast with parboiling – where farm households tend to parboil themselves.

Table 60 Method of milling at farm level in survey states (share of households, n=200)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Hand pounding	14%	19%	0%	8%	0%	10%
Mill	100%	98%	100%	92%	100%	99%

The widespread use of milling services is clearly related to their local availability: over half the survey villages reportedly had at least one rice mill, including over a third of the villages that had more than 3 mills. The distribution of milling services is uneven across the surveyed states (Table 61). The unavailability of local milling services thereby seems to explain - at least to a certain extent – the limited rice processing in Taraba and Benue states. However, there is somewhat of a causality problem as the demand for local rice milling services may be more limited in these states – reflecting lower local rice consumption levels and the common practice of marketing fresh paddy (e.g. for subsequent processing in major processing centers as Abakaleki and Laffia).

Table 61 Rice milling facilities at village level in survey states (share of villages)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
No mill	25%	11%	0%	67%	100%	44%
1-3 mills	38%	44%	0%	11%	0%	20%
> 3 mills	38%	44%	100%	22%	0%	37%

5.3 Rice marketing & storage

5.3.1 Rice marketing

Rice producing households typically sell their paddy to traders (90%). Second most common is to sell to millers (13%, including 7% that were considered as miller-cum-trader). Rice traders normally come from outside village (81% of villages). The place of transaction for rice sales varies – with most sales taking place within the village (40%), at the main market (31%) or at the local market (30%). Sales at the farm itself are uncommon (6% - Table 62).

The peak period of paddy sales is immediately after harvest. For most of the surveyed farmers this period is December to April, with December as the absolute peak month. The peak period is consistent across all states, except Ekiti state. This is a reflection of the upland rice ecology in the latter state and the earlier harvest time.

Table 62 Selected rice transaction indicators at farm level in survey states (share of households)

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Main sales outlet[1] (n=243)						
- Trader	89%	100%	94%	65%	98%	90%
- Miller	0%	6%	42%	26%	4%	13%
Main sales location[1](n=246)						
- Village	20%	45%	75%	29%	41%	40%
- Main market	46%	23%		55%	20%	31%
- Local market	41%	25%	28%	16%	37%	30%
- Farm		25%			4%	6%
Main sales time						
- Peak month	Jan	Dec	Aug	Dec	Dec	Dec
- Peak period	Dec-Apr	Dec-Mar	Aug-Sep	Dec-Apr	Dec-Apr	Dec-Apr

[1]Share of households, with multiple responses.

5.3.2 Rice storage

Almost all rice producing households (99%) store rice in some form and for various purposes. Most common purpose for storage was seed for the subsequent season, as farmers nearly universally (98%) reported retaining seed from the previous harvest. Second most common is storage for consumption – i.e. the storage of the part of the produce retained for subsequent consumption by the household. About three-quarters of the rice producing households reportedly stored rice for sale purposes.

The duration of storage varies and depends on the storage purpose (Table 63). Rice storage for seed and consumption lasts approximately 7 months on average. For seed this typically corresponds with the start of the next production cycle. Rice storage for sale lasts approximately 5 months on average.

The principal means of storage is in bags – irrespective of storage purpose (e.g. storage in bags is reported for 76% of storage for sale, 84% of storage for consumption; 88% of storage for seed). Storage is principally on the compound (in the house/home). Only in Taraba state is storage also common in town (31%).

Table 63 Duration of storage (average, months) by storage purpose at farm level in survey states

State / Storage purpose	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Sale (n=109)	5.6 c	5.2 c	2.5 a	4.1 b	5.5 c	4.9 (.00)
Own consumption (n=133)	5.9 ab	8.0 b	6.1 ab	4.4 a	7.4 b	6.9 (.01)
Seed (n=196)	5.6 b	8.3 c	7.7 c	5.2 a	6.6 b	6.6 (.00)

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

The purpose for storage for seed and consumption is self-explanatory. Storage for sale can have different rationales. For instance, off-season sales can fetch substantially higher prices. Also, stored rice can serve as a potential reserve of cash – whereby rice is sold when needs arise. Despite the potential benefits of storage, rice producing households typically sell a significant share – if not most - of their produce soon after harvest time so as to liquidate debt and replenish cash reserves. Storage for sale thereby implies that rice producers do not market *all* of the produce they intend to market at harvest time, and store a share for later sale. Such practice of storage for sale is near universal in Niger state and widespread in Kaduna and Taraba states (Table 64 – 1st layer). The less frequent use of storage for sale in Ekiti and Benue states could have two different explanations. In the case of Ekiti state we should recall that the time of harvest is substantially earlier than for the other surveyed states. This implies that Ekiti rice producers upon marketing their produce at harvest time are likely to be less affected by depressed rice prices due to the influx of the new rice crop. In fact, the benefits of storage for sale become less obvious for Ekiti farmers, as later sale could imply lower prices. This factor also explains the extremely low levels of stocks remaining for sale at the time of the survey in Ekiti state compared to the other states (Table 64 – 2nd layer): by the time of the survey, most farm households had already liquidated their stocks. The less frequent use of storage for sale in Benue state is likely linked to the combined effects of remoteness of producing areas, low local consumption levels of rice and limited local processing facilities. This may again limit the benefits of storage for sale, as sale after the harvest time could be problematic and increase transaction costs.

Table 64 Storage for sale indicators at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba (52)	Benue	Overall (250)
Stores rice produce for sale (share of households)	96%	76%	44%	85%	57%	74%
Share of produce for sale still in stock	37% d	19% b	3% a	26% c	18% b	22% (.00)

5.3.3 Rice price - quality considerations

Farmers acknowledge that there is a price difference between rice varieties, and particularly between rice qualities (Table 65). The majority of the farmers consider that they grow one of the rice varieties with the highest price. The reason for those that do not grow such variety typically is lack of seed. According to the farmers the quality criteria that determine the price mainly relate to appearance (Table 66). Foreign matter and moisture content were less commonly cited as price determining factors.

Table 65 Farmer opinion about selected price-quality assertions (% reflects share of farmers)

Assertion \ Response	Agree	Do not agree	Do not know
'There is a price difference between rice varieties'	54%	40%	6%
'Farmer him/herself grows rice variety with highest price'	78%	12%	9%
'There is a price difference between rice qualities'	63%	32%	5%
'Farmer could improve the quality of the paddy so as to obtain a higher price'	74%	13%	12%

Table 66 Main quality criteria that determine produce price according to farmers in survey states (share of farmers that perceive quality to influence price, multiple response)

Quality criteria \ State	Niger (n=41)	Kaduna (11)	Ekiti (18)	Taraba (31)	Benue (53)	Overall (154)
Appearance	83%	9%	78%	84%	98%	83%
Foreign matter	0%	9%	67%	16%	57%	31%
Moisture content	56%	82%	0%	7%	9%	25%

A large majority (74%) of the farmers are of the opinion that the quality of the paddy could be improved so as to obtain a higher price (Table 65). This raises the question why then they do not improve the quality of their paddy. Farmers that thought there was scope for quality improvement provided the following reasons for not doing so: (i) do not know how (42% of 173 cases); (ii) time constraints (30%); and (iii) cannot afford improved technology (27%).

5.4 Reported marketing problems

Farmers were asked for their main rice marketing problems. On average, farmers enlisted 2.1 marketing problems. These open responses were subsequently grouped into a number of response categories – of which the main categories are presented in Table 67.[28]

Table 67 Marketing problems reported at farm level in survey states (share of households reporting, multiple responses per household, open responses grouped)

Problem category \ State	Niger (n=53)	Kaduna (51)	Ekiti (36)	Taraba (54)	Benue (54)	Overall (248)
Transport/accessibility problems	79%	61%	22%	80%	50%	61%
Limited demand	4%	39%	56%	22%	50%	33%
Low producer price	9%	37%	19%	24%	44%	27%
Unfavorable market structure for producers	0%	2%	42%	22%	9%	13%
Processing problems	0%	33%	0%	19%	6%	12%
Fluctuation produce price	0%	2%	47%	9%	2%	10%
Lack of capital	0%	0%	0%	39%	0%	9%
Credit problems (lack of, buyer imposed)	4%	2%	25%	2%	0%	5%
Lack of standard measures	0%	0%	17%	0%	7%	4%
Government intervention (lack of, too much)	4%	4%	0%	9%	2%	4%
Quality problems	0%	0%	17%	0%	0%	2%
Availability imported rice	0%	0%	3%	7%	0%	2%
No problem	19%	0%	0%	0%	0%	4%

Underlined are the 2-4 main response categories within the state.

[28] The same two observations can be made as made for Table 54 – i.e. some problems are clearly of local importance only and some problem categories are clearly related.

The most frequently reported category (84%) relates to transport/accessibility problems – including issues such as remoteness and distance to market, density and quality of the road network, access and cost of transport. This category reflects the problems farmers face in bringing their produce to the market. Transport/accessibility problems increase transaction costs and typically imply a lower farm-gate price for a given market price. This category cuts across all states except for Ekiti state. The relative absence of this problem category in Ekiti state is linked to the higher population density in South-West Nigeria and proximity to urban centers.

A number of other categories are related to the structure and functioning of the produce market, including limited demand for local rice (33%), low (27%) and fluctuating (10%) producer prices and an unfavorable market structure for producers (13%). The various subsets are clearly related – e.g. a limited demand normally should translate into a lower price. The same applies to 'unfavorable market structure for producers'. This category reflects what farmers perceive as their limited bargaining power – i.e. that buyers are dictating prices and that farmers have little alternative than to accept these. It is interesting to note that the various produce market related problem categories were variously reported in Ekiti, Kaduna and Benue state, but that these are relatively absent in Niger state. Most likely this is a reflection of rice consumption being traditional in this state, providing a substantial local market and thereby reducing the dependency on the national market as outlet. This also seems to be reflected by the fact that it was only in Niger state that farmers reported not having any marketing problems at all.

Rice processing problems - including limited access to processing facilities - were mentioned by 12% of the farmers, rice quality problems by 2%. A similar number cited the presence of imported rice as a problem – a clear reference to the times of the import ban. It is also interesting to note that 4% of the farmers cited the lack of standard measures as a problem – a particular problem that haunts the rice sector with its numerous measures for seed and produce.[29] Other problems reported included lack of capital and credit problems – the latter including the perceived problem of delayed payment (i.e. farmers feeling forced to accept to sell the produce on credit).

Farmers were also asked to prioritize their main rice marketing problems to come up with the most severe. Figure 9 presents these priority marketing problems. For comparison purposes the same figure includes the overall category, which corresponds with Table 67. As one would expect, the incidence of each problem category is now less frequent.[30] However, overall the relative importance of each category persists – although low producer price moves up a notch. Transport/accessibility problems remain the main category (34%).

5.5 Discussion

The present chapter has shown that rice production is primarily geared towards the market – with on average 80% of the produce being marketed. Rice producing households follow different processing practices. Consumption of produce by the household implies that the household is typically engaged in rice processing (parboiling and milling) for consumption purposes. Only one-third of the rice producing households also engage in rice processing to add value to their produce. Consequently, most produce enters the market as fresh paddy. Parboiling for home consumption is typically done by the farm household. However, there are specialized parboilers that provide parboiling as a service. Milling is typically done in mills – and this has almost completely replaced traditional hand pounding. Most rice is marketed at harvest time but it is widespread practice to store part of the produce for subsequent marketing. Transport/accessibility problems are the main marketing problem

[29] Frequently used measures include 'bags' and 'tins' of various capacities. These non-standard measures vary geographically and depend on the type of content (e.g. paddy or rice).
[30] More or less 50% of the earlier incidence, a reflection of the reduction of 2.1 problems to one.

category faced by farmers – again a reflection of the market orientation of the rice production. However, despite the numerous production and marketing problems faced by farmers, rice producing households are still engaged in significant rice production. What is more, they still produce rice for the market and rice still represents their main source of cash and income. The subsequent chapter will look into the economics of rice production – i.e. the economic attractiveness of rice production under the current setting.

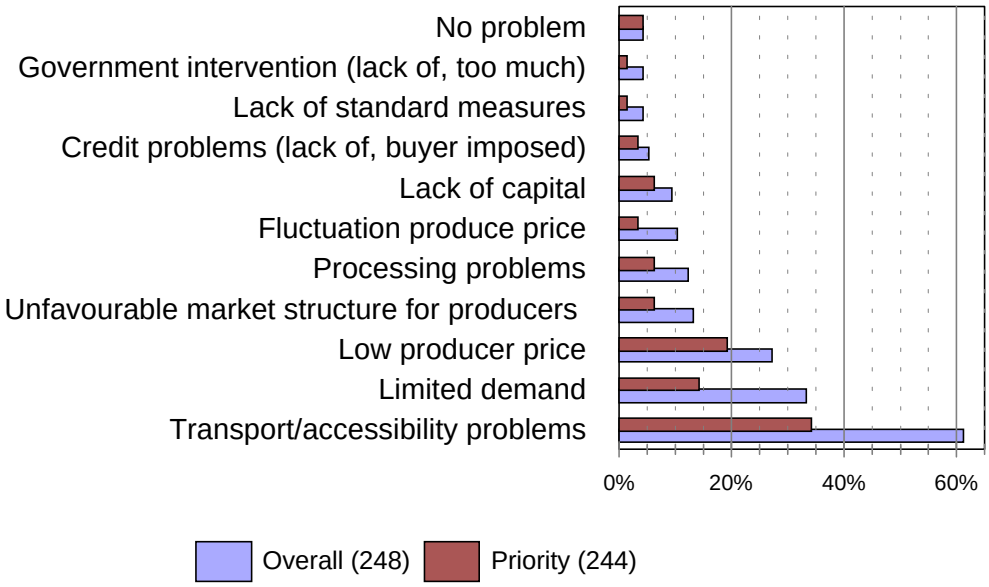

Figure 9 Marketing problems reported at farm level by priority in survey states (share of households reporting)

'Overall' category implies problem being mentioned amongst main problems (multiple responses per household, open responses grouped); 'priority' category implies it was singled out as the most severe problem

6 Economics of rice production

The present chapter reviews the economics of rice production. In doing so it aims to answer a number of questions. What are the rice production costs? What factors determine producer efficiency? This should help to determine whether Nigerian rice producers can compete with imported rice in the end. The chapter first reviews the production costs and second production revenue. This is followed by a review of various performance indicators and a discussion.

6.1 Production costs

The present section reviews production costs, starting with labor use and its valuation. The subsequent sections review input cost and other costs.

6.1.1 Labor use

Rice production is labor intensive and labor input is therefore an important production cost. The single-visit producer survey tried to estimate labor use in the surveyed fields using the recall method. To enhance the reliability of the estimate, labor use questions were focused on the surveyed field only[31] and disaggregated by (i) type of activity and (ii) whether the labor was paid or non-paid. For each combination, an estimate was made by the farmer of the number of days worked and the number of people involved (see Annex 4 for the questionnaire). It is acknowledged that the present method is imperfect. Still, it was opted to use this method in view of budget and time constraints.

The labor data set of 206 surveyed fields were retained. The labor data from the remaining 46 surveyed fields appeared too unreliable. The unreliability appeared to be the combined result of enumerator error and farmer error. Labor data from two complete LGA's[32] were discarded for consistent discrepancies. The other cases appeared to be more a function of farmer error and were less geographically determined.

Of all the rice management practices, the estimates for bird scaring proved the most unreliable and extreme values were corrected. Furthermore, bird scaring has some special features: it is not a universal practice, it is very time demanding and tends to rely on child labor. Consequently, labor aggregates are presented before and after including bird scaring.

Rice production is a labor intensive enterprise. On average, 177 labor days were reportedly used per ha. The labor use varies over the ecologies – being significantly lower for lowland (156 labor days) compared to upland and irrigated (214 and 225 labor days respectively). In view of the limitations of the dataset, these values are of indicative value only – indeed, the labor data are quite variable even after elimination of the unreliable data. The most labor demanding operations across ecologies are the harvest (including manual threshing & winnowing), weeding and land preparation, followed by crop establishment and bird scaring (Table 68).

The relatively low labor total in lowlands is the combined result of relatively low – compared to other ecologies – labor use for weeding and crop establishment, and to a lesser degree land preparation and harvest. This is a reflection of the prevalent crop management practices in lowlands, which tend to rely more on herbicides for weeding, broadcasting for crop establishment and mechanization for land preparation. Indeed, labor use depends significantly on technology used. The prevalent technology use within an ecology is thereby likely more influential for total labor use than the ecology as such – although the two are interdependent. The influence of technology particularly applies to the use of labor-saving technologies for labor-intensive operations, like the use of mechanization and herbicides during land preparation and weeding (Table 69).

[31] And preferably collected during the visit of the selected field to facilitate recall.
[32] There was one enumerator for each LGA. The LGA's in question are Lau in Taraba state and Jemaa in Kaduna state.

On average 43% of the labor needs for rice are met with paid labor. This share is relatively stable across ecologies, being only slightly lower in upland (40%) and higher in irrigated rice fields (56% - Table 68 – last layer). The share of paid labor does present marked differences over the various crop operations. Hired labor is most prominent in the labor demanding operations as land preparation (47% share), weeding (45%) and harvesting, threshing & winnowing (45%), and to a much lesser degree in crop establishment (32%) and pest management (15%). Hired labor is relatively uncommon for fertilizer application (8%) and bird control (3%).

Table 68 Labor use (labor days per ha) by activity in selected field by rice ecology

	Upland (n≥61)	Lowland (n≥133)	(Semi-) Irrigated (n≥12)	Overall (n≥206)
Land preparation	47	40	55	43 (NS)
Crop establishment	27 b	17 a	26 b	20 (.00)
Weeding	56 ab	40 a	70 b	46 (.01)
Fertilizer application	2 a	4 b	5 b	3 (.00)
Pest management	5 b	0 a	0 a	1 (.00)
Harvest & threshing/winnowing	59 b	46 a	44 a	50 (.01)
Total (excl. bird control)	196 ab	146 a	200 b	164 (.01)
Bird control[33]	18 a	10 a	24 b	13 (.00)
Total (incl. bird control)	214 b	156 a	225 b	177 (.01)
Share of paid labor in total labor	40%	43%	56%	43%

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

Table 69 Labor use (labor days per ha) by use of labor-saving technology

	None	Use of traction only	Use of herbicide only	Use of both herbicide & traction	Overall
Total labor use (days per ha)	233 c	101 a	183 b	66 a	177 (.01)
Technology use by ecology (share of households, n=206)					
- Upland	22%	1%	3%	3%	30%
- Lowland	20%	6%	23%	15%	65%
- Irrigated	2%	0%	4%	0%	6%
Total	44%	7%	31%	18%	100%

Data followed by different letters differ significantly - Duncan (.10), within row comparison. Figure in brackets in last column is the probability.

6.1.2 Labor cost

Paid labor is most commonly contracted by day – comprising the payment of a daily wage and typically food. Only occasionally was labor contracted by task (e.g. in Benue state some villages could contract labor for manual tillage for a lump sum of Naira 2000-3400 per ha). Table 70 presents selected indicators in relation to the valuation of labor. On average, the monetary wage rate amounts to Naira 200 per day (over all types of operations). This average is rather similar over three states, but is however substantially higher in Niger State and substantially lower in Ekiti State (Table 70 – first line second layer). Wage rates also vary over operations: land preparation and weeding typically implying higher monetary wage rates (Table 70 - first layer). For comparison purposes, Table 70 (second layer) also includes other estimates of the monetary wage rate. The 'weighted survey

[33] Reported labor use of more than 60 days per ha for bird scaring only was assumed to be 30 days. This affects 8.4% cases.

average' takes into account the actual quantity of paid labor contracted per activity – basically dividing cash labor outlays per household by number of days contracted. The 'village survey average' reflects data from the smaller village sample. This wage rate estimate tends to be somewhat higher than the corresponding weighted and un-weighted indicators from the farm survey. Overall though, there is reasonable correspondence amongst the various wage rate indicators.[34]

Rice producers typically also provide food for the day laborers. This in kind payment is in addition to the cash payment and thereby should be considered as part of the labor cost. On average, approximately two meals – or 'feedings' - are provided to the day laborers, with some variation over the states. It is interesting to note that the number of 'feedings' is highest in Ekiti state, possibly in compensation for the relatively lower monetary wage rates found amongst the surveyed farmers in this state. It is somewhat problematic to obtain reliable estimates of the value of the food provided. In the village survey the informants were asked to provide an estimate of the value of the average meal provided. This yielded responses ranging from Naira 30 to 250 per meal, with 50 and 100 being the most frequent values. Here we assume that Naira 50 per meal is the most reasonable estimate of the value of the meals provided – irrespective of the surveyed state.

With an average of two meals per day contracted, this implies an additional expense of Naira 100 per day. That is, on average, the cost of contracting labor amounts to some Naira 300 per day, comprising a cash component of Naira 200 and an in-kind component of Naira 100.
Table 70 (third and fourth layers respectively) highlights how the estimated value of the food varies over states and the implications for the overall wage rate including both cash and in-kind payments.

Table 70 Valuation of labor for selected rice operations at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Wage rate by operation (excl. food, N/day)						
- Land preparation	252 (81)	211 (56)	174 (24)	188 (14)	204 (51)	219 (226)
- Crop establishment	167 (30)	184 (27)	92 (13)	210 (28)	-	176 (99)
- Weeding	250 (69)	200 (29)	150 (23)	206 (47)	260 (33)	223 (201)
- Harvest & thresh/winnowing	175 (45)	186 (67)	91 (17)	188 (37)	158 (40)	171 (206)
Average wage rate (excl. food, N/day)						
- Farmer survey (un-weighted over operation) [a]	223 (233)	200 (183)	134 (79)	199 (133)	204 (126)	201 (753)
- Farmer survey (weighted over operation) [b]	257 (44)	189 (53)	123 (18)	219 (36)	198 (49)	214 (182)
- Village survey	250 (6)	221 (9)	304 (6)	241 (8)	300 (2)	253 (31)
Average estimated value food (N/day) [c]	86	75	135	78	99	94
Average # of meals per day [c]	1.7	1.5	2.7	1.6	2.0	1.9
Average total wage rate (incl. food, N/day) [c]	343 (50)	271 (36)	266 (32)	292 (34)	308 (54)	301 (206)

[a] Farmer survey average represents average over all activities excluding bird scaring. [b] Weighted average takes into account actual quantity of paid labor contracted per activity. [c] Average for crop budget cases, using LGA average for missing value. Figure in brackets is n: number of observations

For the subsequent crop budgets we need to value both the paid labor and non-paid labor. The valuation of the monetary component of the paid labor is relatively straight forward, as farmers tend to recall such outlays. To this monetary component we have added the estimated value of the food.

[34] Exception to the rule is Ekiti State. The village reported rate is substantially higher than the farmer reported rate. The more so, as the values in Table 70 are for one LGA only. The values for the other LGA appeared dubiously low and were not included in the Table. In the crop budgets the second LGA assumes the average wage rate for the first LGA.

For the non-paid labor we assume an opportunity cost equal to the average wage rate prevalent in the LGA plus the value of food. Indeed, non-paid labor comprises both family labor and exchange labor and their use implies a corresponding opportunity cost.

Table 71 presents the breakdown of the labor costs. Labor costs are substantial, amounting to over N 50,000 per ha on average. Average labor costs vary significantly over the surveyed states, primarily due to variations in labor use (related to technology use) and in addition due to variations in the prevailing wage rate.

Table 71 Breakdown of labor costs at farm level in survey states (only for cases with complete data set)

	Niger (n=50)	Kaduna (n=36)	Ekiti (n=32)	Taraba (n=34)	Benue (n=54)	Overall (n=206)
Paid labor value (N/ha)	26,400	17,600	35,000	7,600	10,600	18,900
- Labor days (per ha)	87	90	132	30	39	73
Family labor imputed value (N/ha)	63,000	17,200	40,900	5,300	23,800	31,800
- Labor days (per ha)	181	62	166	19	79	104
Total imputed labor cost (N/ha)	89,400	34,800	75,900	12,900	34,400	50,700
- Labor days (per ha)	268	152	298	50	118	177
- Wage rate (incl. food, N/day)	343	271	266	292	308	301

6.1.3 Input cost

In section 4.1 we have reviewed crop management practices in the surveyed fields. In the current section emphasis will therefore be on valuation of the input use.

The use of tractors during land preparation is contracted. The variable input costs for traction thereby reflects the service charge paid by the farmer. A few instances used their own oxen for traction – to facilitate comparison these are valued here at their opportunity cost (i.e. the rate farmers would pay for contracting animal traction services). On aggregate, the traction cost amounts to only Naira 1,000 per ha. However, it should be recalled that only a quarter of the households reportedly used traction. Consequently, actual traction costs are significantly higher for those that use traction (i.e. an average of 1.5 passings - harrowing and/or plowing – at an average rate of Naira 2,600 per ha). There is also significant variation of the traction cost over states – a reflection of the combined effect of use rates, number of passings and variable service rates charged (Table 72- first layer).

Seed prices in Table 72 (second layer) are the average farmer reported seed cost. This can represent an actual cash outlay in terms of purchase or an opportunity cost in case the seed used was saved from last years harvest. The average seed cost tends to be somewhat higher than the average paddy sale value – in part a reflection of a premium paid for seed. Seed amounts to a significant share of the variable input cost – in part as all rice producers incur this cost. Rice seed costs vary over states – a reflection of varying reported seed rates and varying seed value. Maize seed costs are marginal – a reflection of limited intercropping and low reported seed rates for those that do (Table 72 – third layer).

Fertilisers are valued at their purchase cost plus transport charges incurred. Fertilizer cost represent the largest variable input cost – averaging Naira 2,700 per ha. The significant variation in fertilizer cost is primarily related to fertilizer use rates and varying application rates (Table 72 – fourth layer). Fertiliser price is relatively similar across the surveyed states. Herbicides presents a similar picture as fertilizers, although average costs are lower (Table 72 – fifth layer).

Table 72 Breakdown of input costs at farm level in survey states (only for cases with complete data set)

	Niger (n=50)	Kaduna (n=36)	Ekiti (n=32)	Taraba (n=34)	Benue (n=54)	Overall (n=206)
Traction services (N/ha) [a]	300	2,300	200	2,600	400	1,000
- Use rate	6%	33%	6%	85%	13%	26%
- # of applications [b]	1.0	2.1	1.5	1.4	1.1	1.5
- Av. unit service charge (N/ha) [b]	4,700	3,300	2,600	1,900	3,300	2,600
Rice seed (N/ha) [a]	1,630	3,710	2,840	1,080	1,960	2,180
- Av. quantity applied (kg/ha) [b]	47	102	82	32	85	70
- Av. unit price (N/kg) [b]	44	37	33	30	23	36
Maize seed (N/ha) [a]	0	0	120	20	0	20
- Use rate			69%	21%		14%
- Av. quantity applied (kg/ha) [b]			2.4	2.3		2.4
- Av. unit price (N/kg) [b]			62	60		61
Fertilizer (N/ha) [a]	5,700	4,000	0	900	1,700	2,700
- Use rate	98%	94%		59%	65%	67%
- Av. quantity applied (kg/ha) [b]	204	128		56	81	133
- Av. unit price (N/kg) [b]	28	33		27	31	30
Herbicide (N/ha) [a]	1,000	2,700	0	1,500	1,800	1,400
- Use rate	44%	58%		79%	57%	49%
- Av. quantity applied (L/ha) [b]	2.1	3.9		1.7	3.2	2.7
- Av. unit price (N/l) [b]	1,000	1,080		980	870	970

[a] Based on all cases (including zero-values). [b] Based on non-zero cases only.

6.1.4 Other costs

The use of external inputs, services and paid labor implies cash outlays. These financial outlays imply financial costs – either as interest paid in the case of credit or opportunity cost in the case of using own funds. The survey compiled the reported interest rates paid, and these rates are variable and depend on a number of factors (see Table 11, page 9). Overall, an annual rate of 10% is assumed here to be a reasonable approximation of the average interest paid. We assume that the average interest paid also provides a reasonable approximation of the opportunity cost in case of using own funds. Six months is assumed here as a reasonable approximation of the duration of the financial outlay. The budgets therefore apply a standard 5% rate (= 10% * 6/12) over all financial outlays as an approximation of the financial costs – irrespective of the source of the funds.

Land is primarily owned or farmers have usufructury rights. This makes the land rental market thin and reliable land rent estimates are scarce. Furthermore, rice production did not seem constrained by land constraints, and particularly in lowlands there seems substantial scope for area increase. Consequently, it is estimated that the opportunity cost of land used for rice production is currently low. In the crop budget the land valuation problem is circumvented by expressing the various return indicators as including the 'return to land'.

Irrigated rice fields incur water charges – but these amount to a nominal Naira 125 per ha only.[35] Additional fixed charges include depreciation of the implements used. Contracted implements are

[35] Irrigation charges were charged on a 'field' basis and were quite constant for the scheme surveyed. It is assumed here that a 'field' corresponds with an acre.

included under service charges, so that the remaining implements used for rice production are mainly hand tools such as hoes and cutlasses. It is assumed that a uniform nominal charge of Naira 500 per ha adequately covers the depreciation of these small tools.

6.2 Revenue

The revenue of paddy production comprises the value of the main product (paddy) and byproducts (maize) in the case of intercropping.

6.2.1 Revenue from paddy

Paddy is primarily produced for the market. All produce was thereby valued at sale value. This implies that the market value is assumed to adequately reflect the opportunity cost of produce not marketed (i.e. produce used for home consumption or other purposes like seed & gifts).

Table 73 presents selected produce price indicators. On average, the reported paddy sales price was N 27 per kg paddy. There is a significant difference over the surveyed states, with Taraba state reporting the lowest prices (N20/kg), Benue state the next lowest (N25) and the other states with similar prices (N 29-30). This price gradient seems a reflection of the distance from major consumption centers – with Taraba state being part of Nigeria's remote East border and neighboring Benue state adjacent but somewhat more centrally located.

Table 73 (2nd layer) also presents selected rice sales prices. However, as the majority of the paddy is sold in its fresh form only a limited number of cases were reported. This makes comparisons with paddy prices and across states somewhat arbitrary.

Rice producers typically incur transport costs upon marketing their produce – especially as sales on the field are uncommon. On average these amounted to N 0.75 per kg, with no significant differences amongst the states.

Paddy is the prevailing form for produce marketing. As such the crop budgets use paddy prices (and consequently do not include processing costs). Table 73 (4th layer) presents the net paddy sales price as used to estimate crop revenue in the crop budgets. This is the reported paddy sales price minus reported transport cost, and using average LGA values (for paddy and/or transport) to replace missing values.

Table 73 Selected produce prices at farm level in survey states

	Niger	Kaduna	Ekiti	Taraba	Benue	Overall
Paddy sales price (N/kg)*	29.2c (54)	30.6c (52)	29.5c (24)	20.2a (46)	25.3b (37)	27.0 [.00] (213)
Rice sales price (N/kg) *	-	40.0 (4)	42.3 (13)	34.5 (4)	57.6 (20)	48.8 (41)
Transport cost (N/kg) *	.74 (32)	.51 (16)	.69 (18)	.83 (33)	.84 (25)	.75 (124)
Net paddy sales price (N/kg paddy)	28.4	30.1	29.3	19.5	24.7	26.2

* Average reported price for three largest produce sales weighted by transaction size. Figure in brackets is n: number of observations. Data followed by different letters differ significantly - Duncan (.10), within row comparison.

Table 74 (1st layer) presents the breakdown of the revenue for paddy.[36] On average, paddy revenue amounts to N 54,000 per ha, the product of an average yield of 2 MT paddy and the average sales price of N 27 per kg. There are significant divergences in paddy revenue – which are clearly related

[36] The table includes only those cases that were retained for the crop budget tables – i.e.. those cases that had all the necessary data to compile the crop budget. Certain indicators may thereby differ from averages presented in earlier chapters.

to the underlying yield and paddy value. Niger, Kaduna and Ekiti state have relatively similar paddy values, so that the divergence in paddy revenue is largely related to the underlying yield differential. At the other extreme is Taraba state, which combines the lowest average yields and the lowest average values. Benue state also has significantly below average revenue, the consequence of having the second lowest average yields and values.

6.2.2 Revenue from maize

A share (14%) of the rice producers intercropped their rice with maize. For those that intercrop, this can represent an important additional source of revenue (e.g. 380 kg @ N 40/kg = N 15,200). However, as the majority of the farmers does not intercrop, the overall average revenue from maize is estimated at only N 2,100. Still, average revenue form maize can be substantial in those areas where intercropping is relatively widespread, as is the case in Ekiti state (Table 74 – 2nd layer).

Due to the prevalence of sole-cropping, gross revenue tends to correspond with paddy revenue (Table 74 – 3rd layer). However, in Ekiti state, the maize revenue represents 15% of gross revenue. In Taraba state, the other state where there is some intercropping, the corresponding share is 7%.

Table 74 Breakdown of revenue at farm level in survey states (only for cases with complete data set)

	Niger (n=50)	Kaduna (n=36)	Ekiti (n=32)	Taraba (n=34)	Benue (n=54)	Overall (n=206)
Paddy revenue (N/ha)	90,700	60,500	67,200	19,000	30,300	54,100
- Paddy yield (kg/ha)	3,200	1,990	2,300	900	1,240	1,960
- Net paddy sales price (N/kg paddy)	28.9	30.6	29.1	21.3	24.7	26.9
Maize revenue (N/ha)[a]	0	0	11,800	1,500	0	2,100
- Maize yield [b]			460 (22)	150 (7)		380 (29)
- Maize price (N/kg) [b]			37.6	48		40
Gross revenue (N/ha)	90,700	60,500	79,000	20,500	30,300	56,200

[a] Based on all cases (including zero-values). [b] Based on non-zero cases only. Figure in brackets is n: number of observations.

6.3 Performance indicators

The present section reviews various performance indicators to asses the economics of rice production. Specifically, the following indicators will be reviewed:

Gross revenue = Revenue paddy + Revenue intercrop
Variable input cost = Traction cost + Seed cost + Fertilizer cost + Herbicide cost
Total operating cost = Variable input cost + Paid labor cost + Interest
Total cost = Total operating cost + Non-paid labor cost + Fixed cost
Value added = Gross revenue – Variable input cost
Current margin[37] = Gross revenue – Total operating cost
Operating ratio = Total operating cost / Gross revenue
Production cost = Total cost / Paddy yield
Gross margin[38] = Gross revenue - Total cost
Gross ratio = Total cost / Gross revenue
Return to labor, mgt & land =
(Gross revenue – Total operating cost – Fixed cost) / Non-paid labor days
Labor productivity = Paddy yield / Total labor days

[37] This corresponds with household income for the rice producing household.
[38] This corresponds with the return to management and land.

The various performance indicators are typically calculated at case level – i.e. before averaging - and the reported values in the tables are the average for the respective indicators. However this approach was not found satisfactory for various ratio-indicators, as extreme ratios exert significant influence on overall average. This makes the interpretation of such indicators somewhat arbitrary – particularly as they can diverge significantly from the other values reported in the same table. Preference was therefore given to present the various ratio-indicators calculated on the basis of averages for independent variable averages mentioned in the tables – i.e. averaging before division, not after. Ratio-indicators calculated in this was are indicated in each table.[39]

The average performance indicators for the whole survey are presented in the last column of Table 75. The indicators highlight that rice generates a gross revenue of nearly Naira 56,200 per ha. With a variable input cost of Naira 7,300 per ha, this represents a value added of Naira 48,800 per ha. Rice production is very labor intensive and relies on a significant contribution of paid labor, Consequently, the current margin – or household income – is only Naira 28,600 per ha. In other words, approximately half (49%) of the gross revenue covers operational costs paid by household, and the other half represents the compensation for the use of household resources (labor, management, land and capital). If we value non-paid labor at its opportunity cost, it appears that the gross margin – or return to land and management - amounts to Naira –3,700 per ha. The gross ratio confers similar information – with a ratio somewhat above 100% indicating total costs (paid plus opportunity costs) are slightly larger than total revenue. A negative gross margin does not imply that the rice producing household is incurring a financial loss in cash. Instead, it basically implies that the remuneration of the household resources in general and the non-paid labor in particular is less than the assumed opportunity cost. That is, potentially the rice producing household had been better off hiring out its labor than devoting it to rice production provided it could be assured a priori of all labor being employed and remunerated at the prevailing wage rate plus food. However, the latter condition is somewhat stringent and explains why rice producing households still engage in rice production as one component in their livelihoods to ensure household income – even when non-paid labor is not fully rewarded at its opportunity cost. The implied reward of non-paid labor is presented as the return to labor, management and land.[40] On average, the non-paid labor (and management and land) is rewarded at Naira 269 per day – significantly lower than the average total wage rate of Naira 300 per day, which was used as opportunity cost.

On aggregate, the production costs amount to Naira 30.5 per kg. This is higher than the net sales price (Naira 26.2 per kg) – reiterating that (i) the average total production costs for paddy are larger than the average paddy revenue, and (ii) average remuneration of non-paid labor is less than its assumed opportunity cost. However, the presented averages mask significant underlying variation. Indeed, a somewhat negative average gross margin typically implies that a number of households are obtaining positive returns. Overall, half the rice producers obtained positive gross margins and 45% achieved competitive production costs (i.e. below their production sales price). Figure 10 illustrates how these two indicators are distributed around the means.[41] What are some of the underlying factors that influence this variation, and thereby determine the attractiveness of rice production? To answer this the subsequent sections review how the various performance indicators are affected by various

[39] Alternatively, we could sum all costs per stratum as if considering one big plot and dividing by the area surveyed. Such an indicator would differ from the one presented in the tables as it would weight the contribution of each farmer by the area cultivated. The present indicator gives equal weight to each farmer irrespective of the area cultivated.

[40] The indicator includes return to land as we did not include the cost of land in the crop budget (see 6.1.4). If we assume the opportunity cost of land to be zero, than the indicator can be interpreted as 'return to non-paid labor and management'.

[41] The production costs histogram excludes one extreme value. This outlier – and the other high production costs depicted – are the result of very low yields. The graph thereby highlights the problem of averaging ratio indicators discussed earlier. Indeed, the average production cost using the ratio before averaging equals Naira 35.7 per kg, whereas the ratio after averaging equals Naira 30.5 per kg.

underlying factors, including state, ecology and technology use. However, to avoid repetition only salient differences will be highlighted.

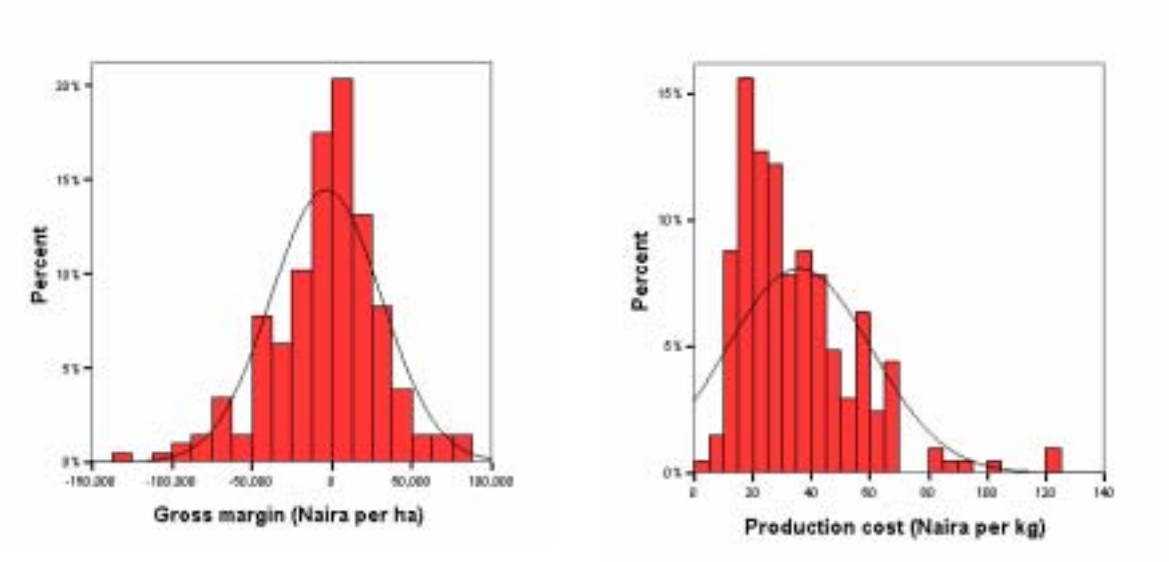

Figure 10 Overall distribution of gross margin and production costs (line depicts normal curve)

6.3.1 Performance indicators by state

Table 75 presents the crop budgets for the surveyed fields by state. From the table it is apparent that:

- Niger state: Combines the highest gross revenue (high paddy yields) with the highest production costs – to a large extend due to its high labor costs. Total costs surpass revenue, resulting in a negative gross margin overall.
- Kaduna state: Combines average gross revenue with below average total production costs. Production costs reflect the highest variable input costs, with relative low labor costs. Results in various positive performance indicators, including the highest average gross margin.
- Ekiti state: Combines the second highest gross revenue with the second highest production costs. Gross revenue is aided by a relatively high contribution of the intercrop and use of improved varieties. Production costs are high due to high labor costs, whereas input costs are low. Total costs again surpass revenue, resulting in a negative gross margin.
- Taraba state: Combines the lowest gross revenue with the lowest total production costs. Production costs are so low due to very low labor costs. Reflects an extensive land use – relying on the use of mechanization and herbicide use, although variable input costs are about average. Results in various positive performance indicators, including the lowest production costs per unit output.
- Benue state: Combines below average gross revenue with below average production costs. Total costs significantly surpass revenue, resulting in the lowest gross margin.

Table 75 Crop budget in selected field by state (Naira per ha, unless indicated otherwise)

	Niger	Kaduna	Ekiti	Taraba	Benue	Total
N	50	36	32	34	54	206
Gross revenue	90 700	60 500	79 000	20 500	30 300	56 200
- Paddy revenue	*90 700*	*60 500*	*67 200*	*19 000*	*30 300*	*54 100*
- Maize revenue	*0*	*0*	*11 800*	*1 500*	*0*	*2 100*
Variable inputs	8 700	12 700	3 100	6 100	5 900	7 300
- Traction services	*300*	*2 300*	*200*	*2 600*	*400*	*1 000*
- Seed	*1 600*	*3 700*	*3 000*	*1 100*	*2 000*	*2 200*
- Fertilizer	*5 700*	*4 000*	*0*	*900*	*1 700*	*2 700*
- Herbicide	*1 000*	*2 700*	*0*	*1 500*	*1 800*	*1 400*
Hired labor	26 400	17 600	35 000	7 600	10 600	18 900
Total operating cost (incl. Interest)	36 800	31 800	40 100	14 300	17 300	27 600
Family labor (imputed value)	63 000	17 200	40 900	5 300	23 800	31 800
Imputed fixed cost	500	500	500	500	500	500
Total production cost	100 300	49 500	81 400	20 200	41 600	59 900
Value added (Naira/ha)	82 100	47 800	75 900	14 400	24 500	48 800
Current margin (Naira/ha)	53 900	28 700	38 900	6 200	13 100	28 600
Operating ratio [a]	41%	53%	51%	70%	57%	49%
Production cost (Naira/kg paddy) [a]	31.1	24.8	35.4	22.5	33.4	30.5
Gross margin (return to land & mgt, Naira/ha)	-9 600	11 000	-2 400	300	-11 300	-3 700
Gross ratio [a]	111%	82%	103%	99%	137%	107%
Return to labor, mgt & land (Naira/day) [a]	294	450	232	294	160	269
Labor productivity (kg paddy/day) [a]	12.0	13.1	7.7	18.0	10.5	11.1
Positive gross margin (share of hh)	50%	81%	56%	50%	26%	50%

[a] Ratio-indicators based on averages for independent variable averages as mentioned in Table – i.e. averaging before division, not after.

The data in the tables are averages and thereby mask the significant variation that exists in the underlying indicators. In Figure 11 a cumulative distribution function is shown for the gross margin in each state. A gross margin of zero implies break-even – i.e. resources are remunerated at their opportunity cost. The graph thereby gives an indication of the share of households that surpass the break-even point. In Kaduna state its high average gross margin is the result of most rice producers (81%) achieving positive returns. In contrast, in Benue state only 26% of the rice producers achieved positive returns. In the other states and for the survey as a whole, half of the rice producers achieved a positive gross margin. The graph also shows that Niger state has the widest spread in gross margins.

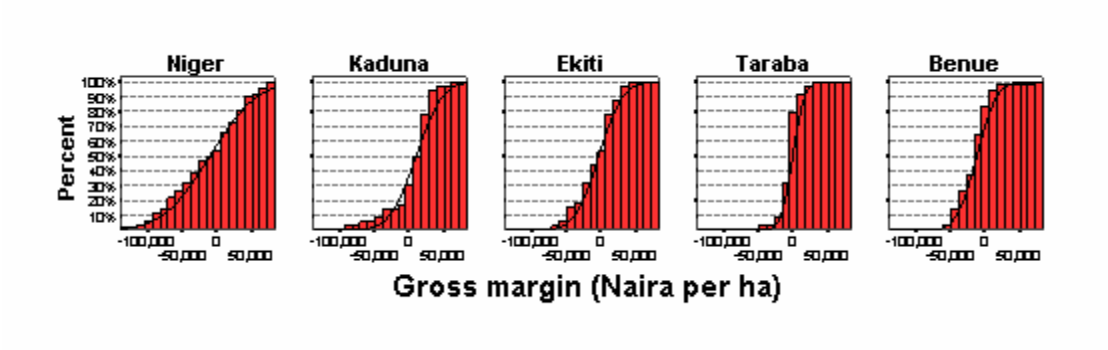

Figure 11 Cumulative distribution of gross margin in surveyed fields by state (Naira per ha)

6.3.2 Performance indicators by ecology

Table 76 presents the crop budgets for the surveyed fields by ecology. From the table it is apparent that the irrigated surveyed fields are the most competitive. They combine high gross revenues with above average production costs. This results in very favorable performance indicators, including low production costs and high gross margins and returns to labor, management and land. The performance indicators for upland are ambivalent – total production costs equate gross revenue, resulting in an insignificant gross margin. The situation is least attractive in lowlands, particularly because of below average revenue (reflecting low yields) whereas production costs are about average. This results in an average negative gross margin for lowlands. Indeed, only 43% of the lowland rice producers attained a positive gross margin. This was significantly higher for irrigated fields (83%) – with upland taking an intermediate position (59%, Figure 12).

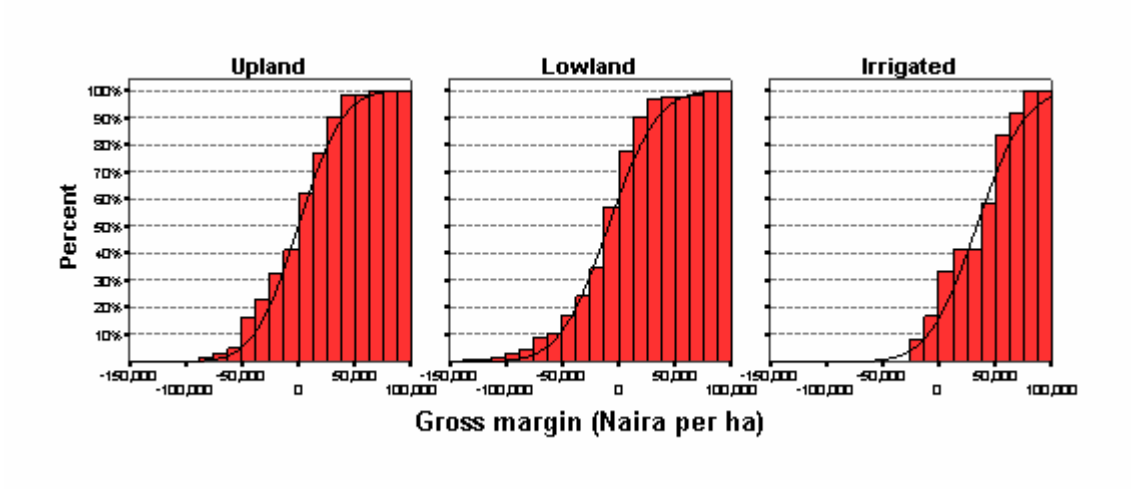

Figure 12 Cumulative distribution of gross margin in surveyed fields by ecology (Naira per ha)

Table 76 Crop budget in selected field by rice ecology

N	Upland 61	Lowland 133	(Semi)Irrigated 12	Overall 206
Gross revenue	64 000	48 700	99 600	56 200
- Paddy revenue	*58 600*	*48 000*	*99 600*	*54 100*
- Maize revenue	*5 500*	*700*	*0*	*2 100*
Variable inputs	6 400	7 800	6 700	7 300
- Traction services	*900*	*1 200*	*0*	*1 000*
- Seed	*3 100*	*1 900*	*1 400*	*2 200*
- Fertilizer	*1 700*	*3 000*	*3 700*	*2 700*
- Herbicide	*800*	*1 700*	*1 700*	*1 400*
Hired labor	24 000	15 300	33 400	18 900
Total operating cost (incl. 10% interest)	31 900	24 300	42 100	27 600
Family labor (imputed value)	31 400	32 700	23 100	31 800
Imputed fixed cost	500	500	600	500
Total production cost	63 800	57 500	65 900	59 900
Value added (Naira/ha)	57 600	40 900	92 900	48 800
Current margin (Naira/ha)	32 100	24 400	57 500	28 600
Operating ratio [a]	50%	50%	42%	49%
Production cost (Naira/kg paddy) [a]	32.3	31.8	18.5	30.5
Gross margin (return to land & mgt, Naira/ha)	200	-8 900	33 700	-3 700
Gross ratio [a]	100%	118%	66%	107%
Return to labor, mgt & land (Naira/day) [a]	263	242	642	269
Labor productivity (kg paddy/day)	9.2	11.6	15.9	11.1
Positive gross margin (share of hh)	59%	43%	83%	50%

[a] Ratio-indicators based on averages for independent variable averages as mentioned in Table.

6.3.3 Performance indicators by production cluster

In section 4.3 we presented production clusters based on field and management characteristics. Table 77 presents the corresponding crop budgets. 'Modern rice production' – found in both lowland and upland – achieves the most attractive returns, mainly because of below-average production costs reflecting external input use to substitute for labor. 'Traditional extensive lowland rice production' achieved similar production costs – but with lower gross revenue and consequently lower returns. In contrast, 'traditional intensified lowland rice production' achieves the highest gross revenue – but also incur the highest production costs, with corresponding effects on the achieved returns. Finally, 'traditional upland rice production' also incurs high-production costs - mainly reflecting high-labor use – which lower returns.

Table 77 Crop budget in selected field by rice production cluster (Naira per ha, unless indicated otherwise)

	Traditional extensive lowland	Traditional intensified lowland	Modern (both lowland & upland)	Traditional upland	Total
N	91	34	25	52	202
Gross revenue	41 700	85 200	50 800	65 800	56 300
- Paddy revenue	*41 300*	*85 200*	*50 300*	*58 600*	*54 200*
- Maize revenue	*400*	*0*	*500*	*7 300*	*2 100*
Variable inputs	7 100	7 600	14 500	4 100	7 300
- Traction services	*1 200*	*0*	*3 200*	*100*	*1 000*
- Seed	*1 700*	*2 000*	*3 200*	*2 900*	*2 200*
- Fertilizer	*2 700*	*4 100*	*4 500*	*800*	*2 700*
- Herbicide	*1 500*	*1 500*	*3 600*	*200*	*1 400*
Hired labor	11 500	30 000	17 700	26 200	19 200
Total operating cost (incl. Interest)	19 600	39 400	33 700	31 800	27 800
Family labor (imputed value)	27 600	53 600	12 400	35 500	32 100
Imputed fixed cost	500	500	500	500	500
Total production cost	47 700	93 600	46 700	67 800	60 500
Value added (Naira/ha)	34 500	77 600	36 300	61 800	49 000
Current margin (Naira/ha)	22 100	45 800	17 000	34 000	28 500
Operating ratio [a]	47%	46%	66%	48%	49%
Production cost (Naira/kg paddy) [a]	33.4	27.0	24.8	34.6	30.8
Gross margin (return to land & mgt, Naira/ha)	-6 000	-8 400	4 100	-2 000	-4 100
Gross ratio [a]	114%	110%	92%	103%	107%
Return to labor, mgt & land (Naira/day) [a]	259	284	321	246	265
Labor productivity (kg paddy/day) [a]	11.6	13.1	13.0	8.2	10.9
Positive Gross return (share of hh)	36%	53%	76%	56%	49%

[a] Ratio-indicators based on averages for independent variable averages as mentioned in Table – i.e. averaging before division, not after.

6.3.4 Performance indicators by labor-saving technology use

The preceding crop budgets show that labor costs are the largest production cost - irrespective of state, ecology or production cluster. Farmers have responded to this through the use of labor-saving technology, including the use of traction and herbicides during land preparation and weeding. Indeed, the use of these technologies implies substantial labor-savings (Table 69). So far, the cost of these technologies has been included under the variable input costs, whereby other factors (state, ecology or production cluster) determined the share of producers using the technology. However, this blurs the effect of the technology use, as each category comprises both technology users and non-users. The present section therefore singles out labor-saving technology to assess its affect in view of the high labor costs.

Table 78 presents the crop budgets for rice producers based on the four categories of labor-saving technology use. It appears that particularly traction is very attractive: users of traction have

drastically lower labor costs and relatively favorable returns. Herbicide-use also has a favorable effect on the returns – but its effect is less pronounced and more variable (eg Figure 13). The producers that used both technologies achieved the most attractive returns.

It is interesting to note that traction-users obtain relatively low gross revenues – typically reflecting low yields. However, the saving in production costs more than outweighs the relatively low revenues. This suggests that traction-users use relatively extensive production practices – but that this still is an attractive option in terms of cost control. The advantages of labor-saving technologies hold both over states and ecology.

Table 78 Crop budget in selected field by labor-saving technology use (Naira per ha, unless indicated otherwise)

	None	Traction only	Herbicides only	Herbicides & Traction	Total
N	90	15	63	38	206
Gross revenue	68 400	41 900	53 200	37 700	56 200
- Paddy revenue	*64 600*	*38 800*	*52 900*	*37 200*	*54 100*
- Maize revenue	*3 800*	*3 100*	*300*	*500*	*2 100*
Variable inputs	5 200	6 500	7 700	12 100	7 300
- Traction services	*0*	*2 900*	*0*	*4 500*	*1 000*
- Seed	*2 500*	*1 300*	*2 000*	*2 200*	*2 200*
- Fertilizer	*2 700*	*2 300*	*2 800*	*2 500*	*2 700*
- Herbicide	*0*	*0*	*2 900*	*2 900*	*1 400*
Hired labor	22 800	11 300	19 600	11 600	18 900
Total operating cost (incl. Interest)	29 500	18 700	28 700	24 900	27 600
Family labor (imputed value)	48 000	16 500	28 900	4 200	31 800
Imputed fixed cost	500	500	500	500	500
Total production cost	78 000	35 700	58 000	29 500	59 900
Value added (Naira/ha)	63 200	35 400	45 600	25 600	48 800
Current margin (Naira/ha)	39 000	23 200	24 600	12 800	28 600
Operating ratio [a]	43%	45%	54%	66%	49%
Production cost (Naira/kg paddy) [a]	35.6	27.8	27.8	20.1	30.5
Gross margin (return to land & mgt, Naira/ha)	-9 500	6 200	-4 800	8 200	-3 700
Gross ratio [a]	114%	85%	109%	78%	107%
Return to labor, mgt & land (Naira/day) [a]	248	362	252	777	269
Labor productivity (kg paddy/day) [a]	9.4	12.8	11.4	22.2	11.1
Positive gross margin (share of hh)	47%	47%	44%	68%	50%

[a] Ratio-indicators based on averages for independent variable averages as mentioned in Table – i.e. averaging before division, not after.

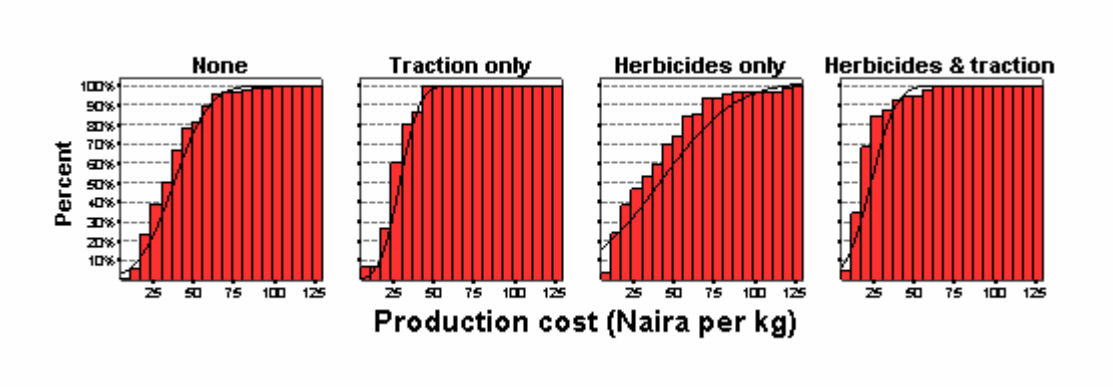

Figure 13 Cumulative distribution of production cost (Naira per kg) by use of labor-saving technology

6.4 Discussion

The preceding analysis shows that rice producers typically obtain variable but somewhat limited returns to rice production. Paid expenses are easily recovered, but the average remuneration of households resources barely covers its estimated opportunity costs. The fact that the surveyed rice producers adhere to rice production has a number of likely causes. First, rice producers may have limited alternatives to use their labor remuneratively. This implies that the assumed opportunity cost of non-paid labor may overestimate the actual cost – i.e. rice producing households may not always be able to obtain the implied remuneration on-farm or off-farm. Second, rice producers may have limited alternatives to generate cash income. Rice production is indeed widely perceived as source of cash/income by the rice producing household and is primarily produced for the market. Third, rice producers may have limited alternatives in terms of using lowlands productively. Lowland rice is found in lowlands which are typically waterlogged or subject to flooding. Without substantial investments, these lowlands often have limited other productive alternatives to rice – particularly during the rainy season. This also implies that the current opportunity costs for using such lowlands for rice are limited. Lowland rice also allows for diversification of crops and ecologies used – adding to the portfolio of activities pursued and reducing household income risk. Consequently, rice cultivation in general, and lowland rice in particular, may still be attractive to farmers even when the estimated returns appear somewhat limited.

The returns to rice production are variously affected by ecology, production technology and location. The preceding analysis has highlighted the favorable effects of: (i) water management and improved varieties (particularly in terms of higher yields and revenue); and (ii) labor-saving technology (particularly in terms of reducing labor use, being the major production cost). The effect of location reflects the combined effect of production costs, produce value and productivity differentials.

Although certain tendencies are clear, a number of issues should be recalled. First, the data reflect survey data for 252 households. This implies that we cannot control for all factors – or single out the effect of one specific factor for that matter. Indeed, the surveyed rice producing households differ in terms of their resource base, activities and efficiency – and in part this is associated with each other and with ecology, technology use and location. Also, being single-survey data, there are certain measurement errors we can not fully control for. This particularly affects labor use – which in itself is the major production cost – but also some other variables. Therefore data presented here should be seen as indicative estimates, which can be made more reliable by more exact measurements. Furthermore, the crop budgets implicitly assume constant returns to scale by bringing budgets to a ha basis and not controlling for field or farm size. Still, this assumption seems warranted within the range of surveyed field/farm sizes in view of the limited capital base used for rice production. Indeed, the surveyed rice producers using tractors relied on contracted services – making such lumpy

technology divisible. Finally, the data presented here refer to rice producing households only. Returns for households that contemplate starting rice production may be different – for instance in terms of access to markets and services (e.g. rice processing, rice traders, rice seed) and start-up costs (eg learning costs). Similarly, households that have abandoned rice production may have done so for reasons that are less evident amongst current rice producers.

Whatever the limitations of the dataset, the foregoing analysis does highlight substantial scope and need for (i) higher yields and (ii) lower production costs in general, and labor costs in particular. Such improvements would imply significant increases in the returns to rice production. Also, the two are complementary and not necessarily contradictory. For instance, the use of improved varieties can imply significant yield increases with relatively similar production costs. Similarly, integrated crop management practices can reduce production costs while maintaining yield levels, for instance through improved labor and input use efficiency.

7 In conclusion

Rice is first and foremost a cash crop for Nigerian rice producers – i.e. it is produced primarily for the market. This marked market orientation reflects that both rice production and rice consumption are non-traditional in much of Nigeria.

The present survey has characterized rice producers and rice production systems. Rice producing farm households are primarily small-holders with limited capital resources. They cultivate an average of 8 ha with crops per year – of which 3.3 ha are devoted to rice. Crop farming typically is the main source of household income, but households variously supplement their income with livestock and off-farm sources of income.

Rice is typically the main crop for rice producing households in terms of area allocation and income. Where rice production is established, it is widespread within the village/region and appears relatively stable with a long history. This reflects that rice production is attractive in survey areas, even despite the relatively limited returns and substantial policy changes over the last decades. This also suggests that rice producers may lack alternatives – in terms of remunerative opportunities to generate cash and/or to use their labor and land resources productively. In particular this seems to apply to lowland and remote areas. Still, it needs to be reiterated that the survey only addresses current rice producers. It thereby does not address those that have stopped with rice production. Indeed, in other areas producers may have entered and subsequently left rice production.

The survey has highlighted that returns to rice production are relatively limited. This implies a need to enhance productivity and reduce production costs to enhance competitiveness. Rice production is labor intensive and labor represents the major production cost and cash outlay. Improving labor productivity is primordial and the use of labor-saving technology – e.g. traction and herbicides - offers substantial promise. The market orientation of rice production inherently enables external input use. Indeed, rice producers are already willing to invest to some degree in the use of productivity enhancing technologies– even without input subsidies and in an uncertain policy environment. The surveyed rice producers variously used fertilizer (62%), herbicides (52%) and traction for land preparation (27%). External input use not only allows to increase productivity, but also can help ensure the sustainability of rice production systems.

Despite substantial use of external inputs as fertilizer and herbicides, input use efficiency is low. Indeed, rice yields are relatively low - 1.9 tons per ha - and there is substantial scope for increasing yields and enhancing input use efficiency. An underutilized venue to enhance productivity is the use of improved varieties. Indeed, numerous rice producers still rely on traditional varieties (e.g. also see Longtau, 2003) – with characteristic low yields, limited response to fertilizer and long growing cycles. Improved varieties currently in use by some farmers already show that with the present varietal basket substantial improvements are possible. The addition of new improved genetic material to the varietal basket should allow for further substantial increases in rice productivity (Osiname, 2003) – even when maintaining current input use levels. The upland rice producers in Ekiti state are a case in point – achieving acceptable yields by using improved varieties even without fertilizer.

Location variously affects the returns to rice production – in terms of production costs, produce value and productivity differentials. Production costs are to a large extent determined by technology use and resource costs. Produce value is to a large extent determined by access to rice consumer centers. Productivity differentials reflect technology use and ecology. Indeed, significant variation in land productivity (yield) exists over the surveyed locations.

The ecology of the rice field influences the returns to rice production. Lowlands without water control were the most common rice production ecology amongst the surveyed fields – but comprise

substantial variation in terms of water-logging, flooding levels and topography. However, relatively low yields and about average production costs imply meager and variable returns to rice production. Irrigated fields - i.e. lowland fields with water control -performed substantially better and achieved attractive economic returns. Still, it should be recalled that the irrigated sub-sample is relatively small and coming from Niger state only – a consequence of the sampling frame used. A complementary study specifically looks into the potential of irrigated rice across several schemes in different states (Kebbeh et al, 2003). It should also be remembered that water control typically implies substantial investments. The returns to irrigated rice production presented here are the private returns – which do not take into account previous irrigation investments (a public sunk cost) whereas the producer only pays a nominal water charge. The social returns to irrigated rice production are likely to be less attractive – particularly when new infrastructure needs to be developed. Priority should therefore be given to enhancing the efficient utilization of existing operational irrigation schemes. Furthermore, private and small-scale improvements in water control at the field level (e.g. use of bunding) may be worth exploring as venues to enhance land productivity.

A variety of rice production systems and technological levels co-exist. Although all would benefit from reduced production costs and enhanced productivity, no single solution is likely to fit all. Indeed, rice producers have already variously adapted to their varying circumstances. For instance, although only limited levels of mechanization were found, these are especially common for land preparation in the floodplains of remote Taraba state. These rice producers thereby seemed to rely on traction – primarily tractors, with limited animal traction – to cultivate substantial rice areas despite labor constraints and to ensure the timeliness of establishment. Subsequent crop management was relatively extensive and yields low. Other rice producers follow other strategies in terms of labor and input use. In this regard different productivity enhancing strategies are needed depending on the circumstances.

Despite substantial external input use, access to external inputs can be problematic. Many rice producing households also face working capital problems – i.e. the ability and cost of financing production costs. At the same time transport and accessibility problems are widespread. For rice production to become more attractive and competitive, an enabling environment is needed – whereby access to markets (both input and output) is a key component. Physical access to markets is thereby a necessary but insufficient condition for competitive rice production. There is also a need to reduce transaction costs in general. Standardization of units and quality grades and access to market information (price information) have a significant role to play. Market information is likely to increase the bargaining power of producers, particularly in remote areas. Bargaining power of rice producers may be further enhanced by rice producer organization – which would also facilitate access to markets and facilitate information supply/distribution. Finally, an enabling environment also implies a stable and consistent policy environment – something which has not been evident for rice producers in Nigeria (Akpokodje et al., 2001).

The present study mainly emphasized rice producers and rice production. It is acknowledged that rice production competes with other crops and activities for scarce household resources. In part this is reflected in the assumed opportunity costs. Still, a better understanding of all these competing activities would help to better interpret the findings of this study. However, the diversity of rice production systems and corresponding implications for production costs was already daunting for one single study – let alone if we had to simultaneously capture all other activities which vary over the surveyed states. The outcome of this survey hopefully can serve as basis for a better understanding of rice production and for subsequent complementary studies to compare rice to other crops and/or activities.

Locally produced rice competes with other products on the food market. First, it competes with other locally produced foodstuffs – such as other cereals and roots & tubers. However, the persistent gradual increase in rice consumption levels in Nigeria has highlighted that rice has become a

structural component in the Nigerian diet. Indeed, changes in relative commodity prices have slowed but not reversed the increase – suggesting that this type of competition is relatively limited. More stringent for local rice is the competition with imported rice. Indeed, the price of imported rice puts a cap on the price of local produce – basically a function of world market price, import duties, transport costs and quality premium. Still, local rice is an imperfect substitute for imported rice – as imported rice is widely perceived to be of better quality and therefore commanding a higher price. The crop budgets reflect that at the prevalent prices at the time of the survey and with the assumed opportunity costs, half the rice producers were price competitive. The recent increase in the import duty on imported rice should imply more favorable producer prices for rice – which in turn should imply more favorable returns to rice production, *ceteris paribus*.

Import duties are one way to make local rice production more economically attractive. However, import duties should be seen as a temporary measure and more structural improvements in the rice sector are needed to make the rice producers competitive with imported rice. This basically requires a two-pronged approach. First, substantial productivity increases in rice production are needed to lower production costs. Second, the persistent quality problems of Nigerian rice need to be addressed. Indeed, the quality differential between local and imported rice implies a price differential that can only be reduced if the quality of local rice is drastically improved. This requires integrated quality management along the entire commodity chain – from rice production, through processing and marketing. Indeed, different steps potentially influence the quality of the end product, including production, harvest, threshing, parboiling, drying, milling, storage and marketing. The survey has shown that different actors involved in each step – implying the need to include all stakeholders in quality management. In the end, local rice can only become competitive with imported rice if it can compete both in terms of price and quality.

References

Akpokodje, G, F. Lançon and O. Erenstein, 2001. Nigeria's rice economy: State of the art. Paper presented at the NISER/WARDA Nigerian Rice Economy Stakeholders Workshop, Ibadan, 8-9 November 2001. Bouake: WARDA.

Ezedinma, C.I., 2001. Economic evaluation and prospects for double rice crop production in humid forest inland valley ecosystems of South Eastern Nigeria. Tropicultura, 19:161-165 pp.

Kebbeh, M. S. Haefele and S.O. Fagade, 2003. Challenges and opportunities for improving irrigated rice productivity in Nigeria. Abidjan: WARDA.

Lançon, F., O. Erenstein, S.O. Akande, S.O. Titilola, G. Akpokodje and O.O. Ogundele, 2003a. Rice processing in Nigeria : A survey. Abidjan: WARDA.

Lançon, F., O. Erenstein, S.O. Akande, S.O. Titilola, G. Akpokodje and O.O. Ogundele, 2003b. Imported Rice retailing and Purchasing in Nigeria: A survey. Abidjan: WARDA.

Longtau, Selbut R. 2003. Nigeria case study report on rice production. Multi-agency partnerships for Technical change in West African agriculture (MAPS). Jos, Nigeria:Eco-systems development organization (EDO) for Overseas development institute (ODI) (www.odi.org.uk/rpeg/maps/nigeria.pdf).

Osiname, O. 2003. Participatory varietal selection trials for NERICAs in Nigeria. Internal report. Ibadan: WARDA.

Singh, B. N., Fagade, S., Ukwungwu, M. N., William, C., Jagtap, S. S., Oladimeji, O., Efisue, A., and Okhidievbie, O. 1997. Rice growing environments and biophysical constraints in different agro-ecological zones of Nigeria. Met.J.2 1, 35-44.

Annex 1 Survey sites

State	LGA	Village
Niger	Gurara	Kwaka, Tufa, Lambata
	Gbako	Edozhigi, Wuya Suma, Emitsofo
	Mokwa	Labozhi, Kpambo, Ekpagi
Kaduna	Kajuru	Gefe, Kufana, Kasuma Mangani
	Jemaa	Jagindi Gari, Jagindi Tasha, Godo-godo
	Igabi	Gadan-gayan, Igabi, Turunku Iso
Benue	Agatu	Obagaji, Ologba, Ayele
	Gwer west	Tse-Adudu, Tse-Atunku, Jimba
	V/kya	Tse Udu, Tse-Atule, Tse Kpum
Taraba	Gassol	Mai Gemu-Kanu, Taka Wurkun, Shagarda
	Lau	Garin Dogo, Mayo Lushi, Garin Mashi
	Wukari	Nwuko, Rafin-Kada, Tudunwada
Ekiti	Ikole	Ayedun, Ara-Ekiti, Ijesa-Isu
	Ekiti west	Erio-Ekiti, Ido Ajinare, Okemesi-Ekiti

Annex 2 Crop calendars by state

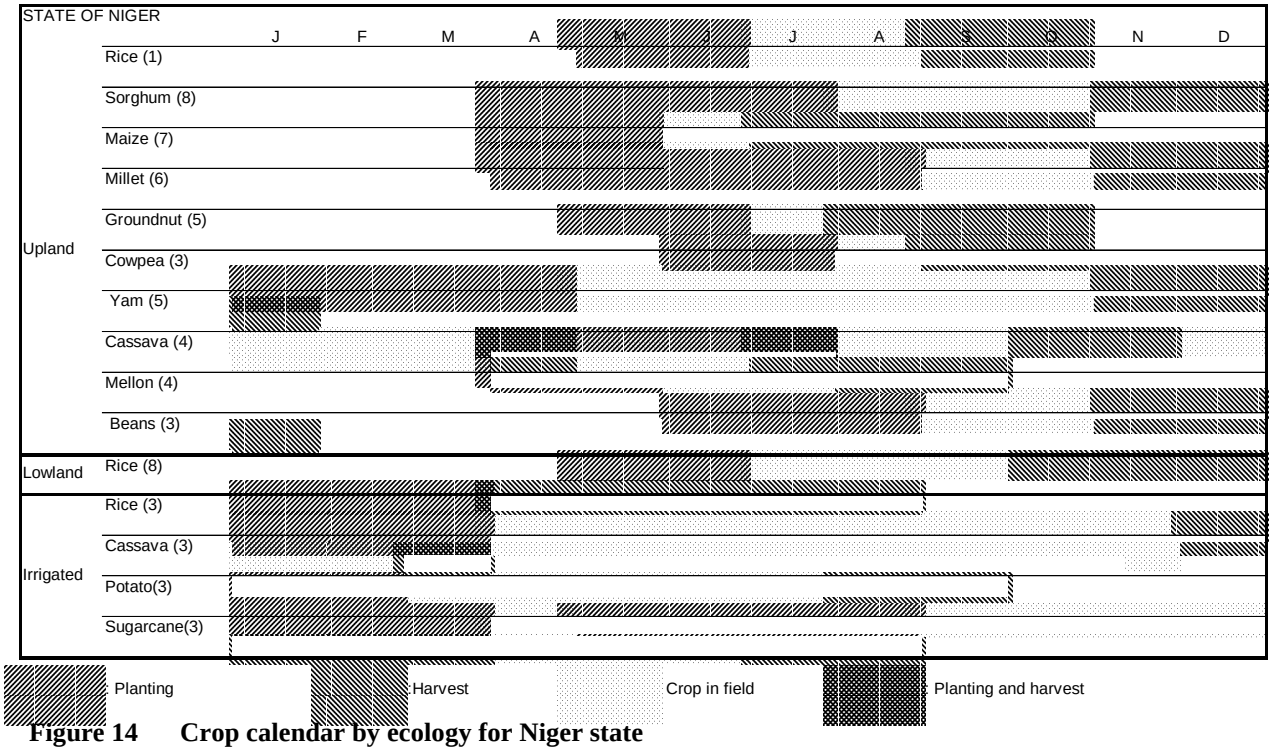

Figure 14 Crop calendar by ecology for Niger state

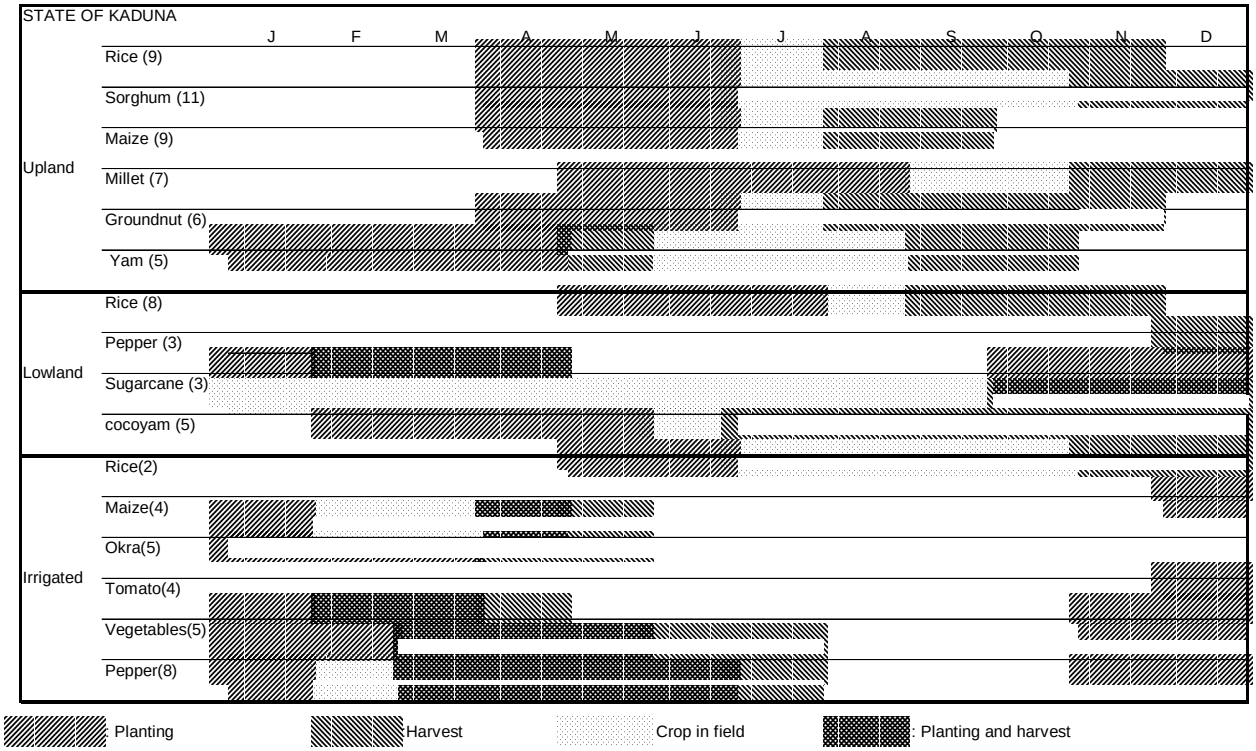

Figure 15 Crop calendar by ecology for Kaduna state

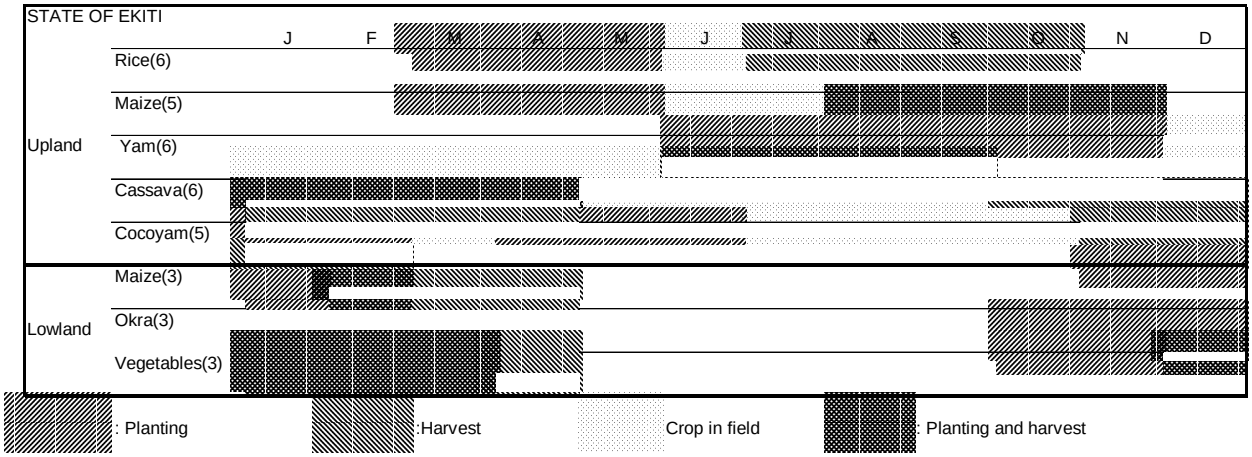

Figure 16 Crop calendar by ecology for Ekiti state

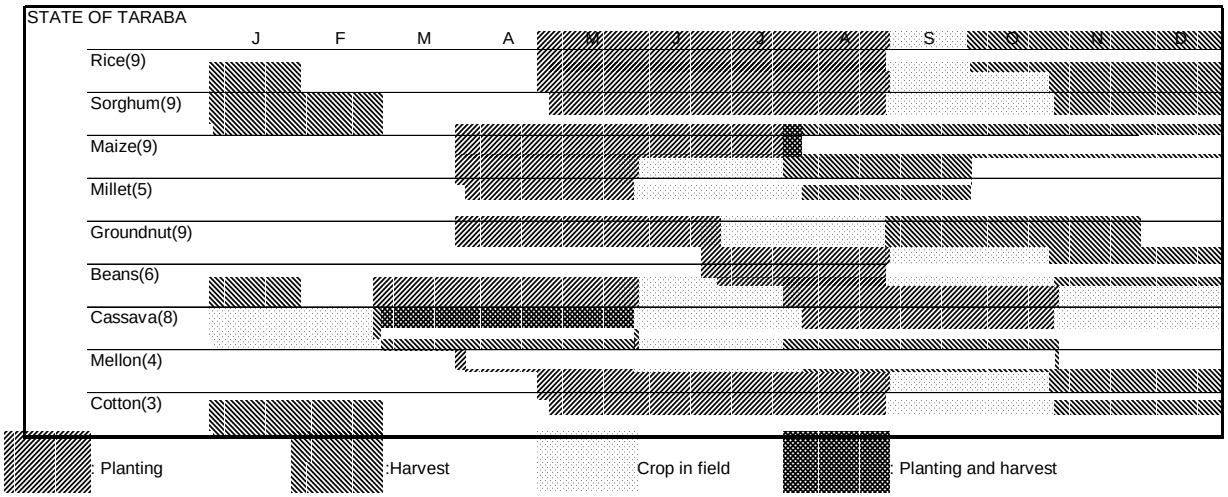

Figure 17 Crop calendar for Taraba state

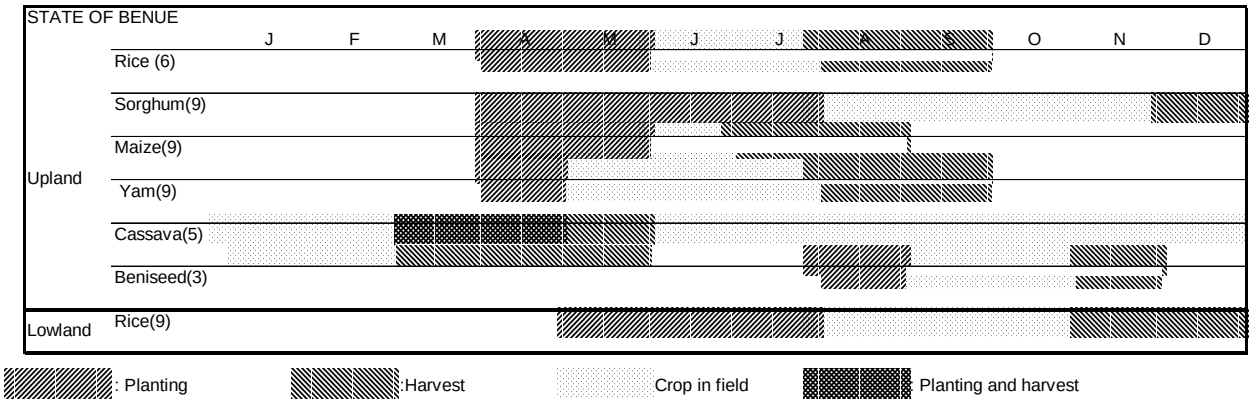

Figure 18 Crop calendar by ecology for Benue state

Annex 3 Cultural calendars by state

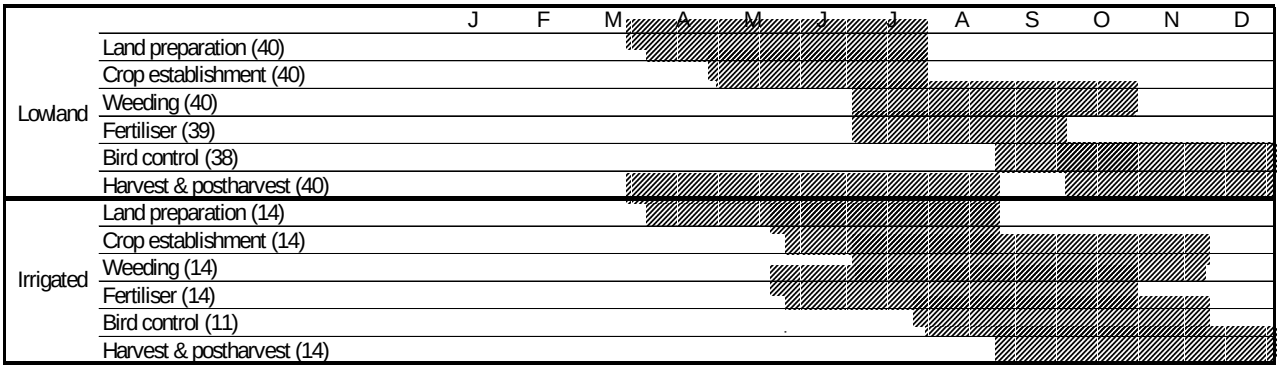

Figure 19 Rice cultural calendar by ecology in Niger state

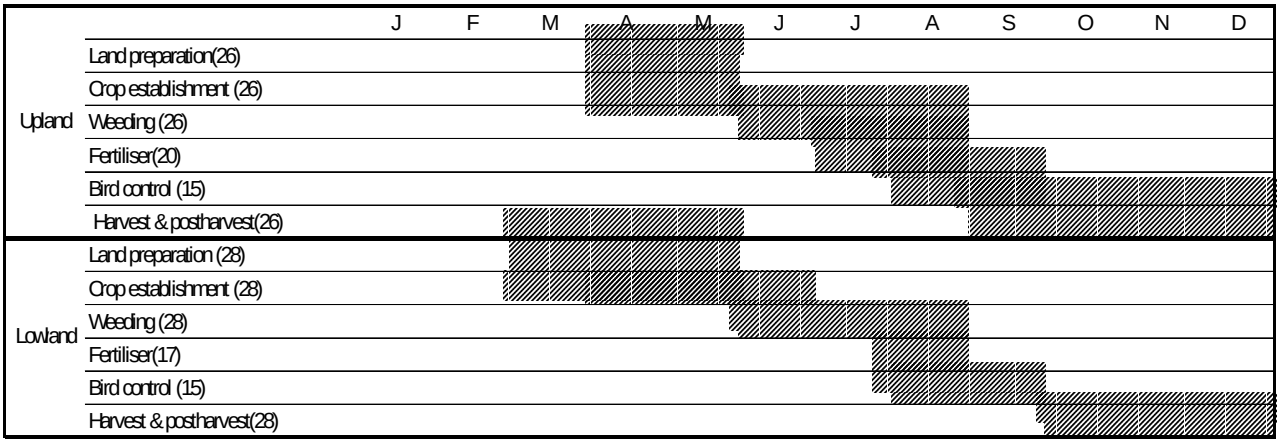

Figure 20 Rice cultural calendar by ecology in Kaduna state

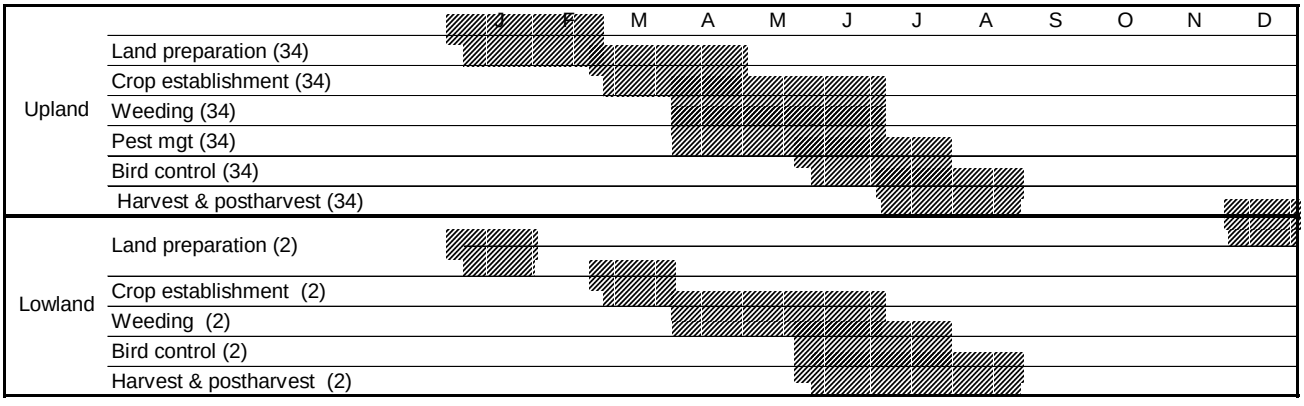

Figure 21 Rice cultural calendar by ecology in Ekiti state

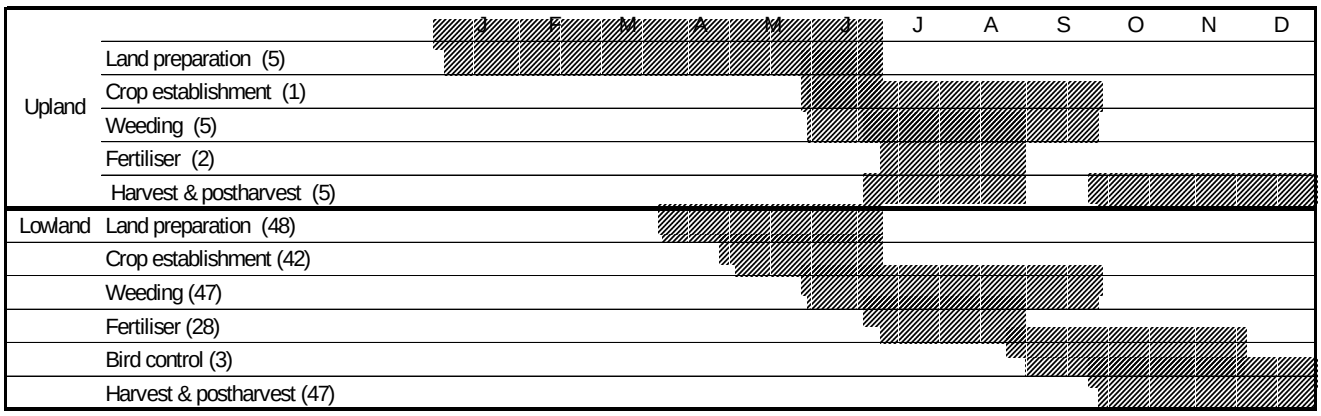

Figure 22 Rice cultural calendar by ecology in Taraba state

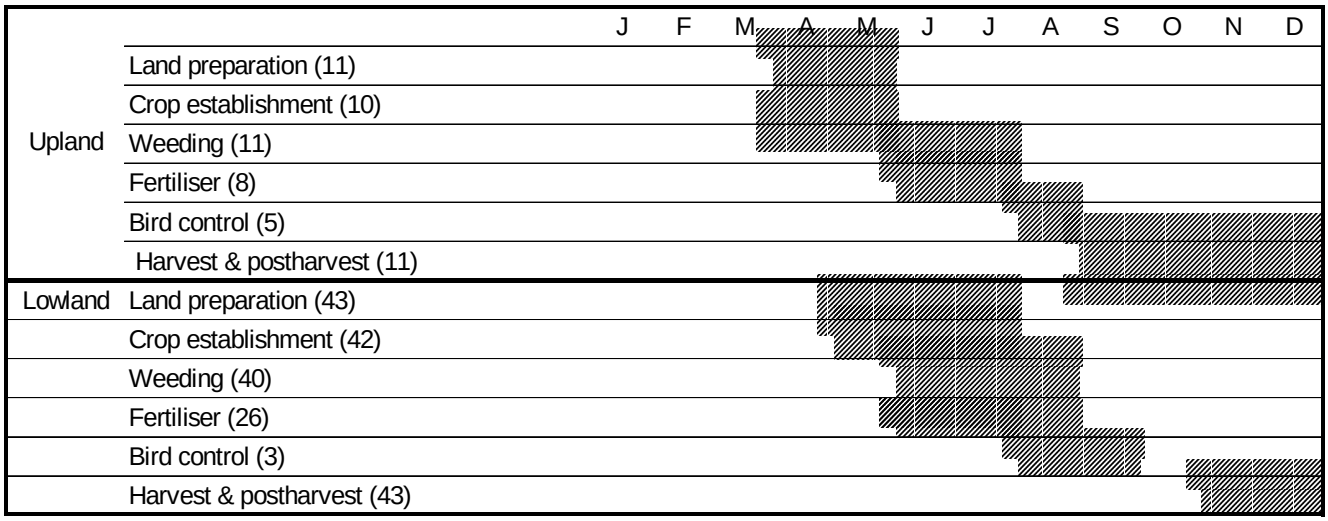

Figure 23 Rice cultural calendar by ecology in Benue state

A. General

A1. Questionnaire number: P……. A2. State: ……

A3. LGA: …….. A4. Village: ……..

A5. Farmer name: ……..…… A6. Produced rice in 2001? *0. No; 1. Yes*

A7. Enumerator name: ……..…… A8. Reviewed by: ……..……

A9. Interview date: …/…/…… A10. Review date: …/…/……

B. Producer and household characteristics

B1. Age household head: …….. B2. Sex household head*: 1. male 2. female*

B3. Ethnic group household head: …….. *Specify: 1. Native 2. Non-native*

B4. Relationship of informant to household head: *1. Household head self; 2. Child; 3. Spouse; 4. Other (spec)……*

B5. Can household head read? *0. No 1. Yes* *Specify: 1. Arabic 2. English*

B6. Up to what level did household head attend school?
0. None; 1. Koranic; 2. Pre-primary; 3. Primary; 4. Pre-secondary; 5. Secondary; 6. Tertiary or higher

B7. What is the distance between your house and the village center? …….. metres

B8. What is the composition and occupation of your household?

	Composition		Main occupation [*]					
Type	# Male	# Female	# farming on farm	# at school	# other activities	# stay primarily off farm	# too young /too old	# other ……
Household head								
Wife(s)								
Children								
Adult relatives								
Child relatives								
Others								

[*] Ensure that row total of right hand side corresponds with left hand side of table. #: number

B9. What types of labor do you use to supplement the family labor?
0. None; 1. Hired laborers; 2. Labor exchange; 3. Other……..

B10. Do you or other family members also work as a hired laborer elsewhere? *0. No; 1. Yes*

C. Land use

C1. Land use last year for all household plots *(include fields from other household members & fallow. Identify and list plots and indicate for each)*

	Main season 2001				Minor season 2001						
Plot #	Crop planted	Estimated plot size *(spec. unit)*	Main use produce *(tick)*	*If rice crop,* rice production plot *(indicate unit)*	Crop planted	Area used	Main use produce *(tick)*	*If rice crop,* rice production plot *(indicate unit)*	Land type *(tick code)*	Plot ownership *(tick code)*	Plot manager *(tick code)*
1	Rice		S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
2			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
3			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
4			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
5			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
6			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
7			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
8			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
9			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
10			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
11			S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
12	Fallow (length: ……..)		S / C / ...				S / C / ...		U / L / I /	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. ....
	Indicate main crops by name (eg rice; cassava-yam mixed). Include tree crops and fallow. If fallow indicate length	*Indicate unit. Ask in local units as needed & provide conversion factors. If no size estimate, compare field to largest rice field*	*S:. Sale C. Consumption O. Other .....*	*Indicate unit and weight conversion factor for bags, mudus, etc*			*S:. Sale C. Consumption O. Other .....*	*Indicate unit and weight conversion factor*	*U. Upland; L:. Lowland; I: Irrigated; Other .....*	*1. Usufruct [see *] 2. Owner 3. Sharecropped 4. Rented in 5. Rented out 6. Other*	*1. Household head; 2. Wife; 3. Child; 4. Other……,*

Specifically ask about any plots cultivated by other household members, being fallow, leased in or leased out to others– and include these in above list. As aid draw plots one by one on ground to facilitate identification.

[*] Usufruct: Land is not owned by user, but all products from land are for user without compensation/payment to owner (e.g. village chief)

C2. What types of livestock do you have?

Type	Actual #	# sold last year	Price obtained *(spec unit)*	Type	Actual #	# sold last year	Price obtained *(spec unit)*
……	……	……	……	……	……	……	……
……	……	……	……	……	……	……	……

C3. What types of trees do you have? *(#: number; Sell: N: No; Y:Yes)*

Type	#	Sell	Type	#	Sell	Type	#	Sell
……	……	N / Y	……	……	N / Y	……	……	N / Y
……	……	N / Y	……	……	N / Y	……	……	N / Y

C4. What is your main farm activity? *(tick one)* *1. Crop farming; 2. Livestock; 3. Trees; 4. Other ……*

C5. Which of your crops is the most important source of cash? ……..

C6. Which of your crops is the most important source of food? ……..

C7. Do you have other off-farm sources of income? *(tick one and specify)*
0. None; 1. Salaried work……; 2. Commerce; 3. Transport; 4. Remittances; 5. Other ……

C8. What is the main source of income on an annual basis? *(tick one)* *1. Farm; 2. Off farm*

C9. Did your household change its rice area during the last five years? *(tick one)*
0. No change; 1. Increased; 2. Decreased; 3. Other ……

If changed:

C10. Why did it change? ……
……

C11. Any significant changes in the household area devoted to other crops during the last five years?
Crop …….. *1. Increased; 2. Decreased; 3. Other ……*
Crop …….. *1. Increased; 2. Decreased; 3. Other ……*

D. Other farm household resources & procurement

D1. Do you have large agricultural equipment or assets? *(eg tractor; pump; processing equipment)* *0. No; 1. Yes*

Type	#	Still operational	Type	#	Still operational
……	……	N / Y	……	……	N / Y
……	……	N / Y	……	……	N / Y

D2. Did you hire/borrow any types of agricultural equipment from others last year? *0. No; 1. Yes*

If yes D3. Type: …… Purpose: …… Conditions/cost: ……

D4. Do you have a means of transport within household? *0. No; 1. Bicycle; 2. Motorcycle; 3. Car; 4. Other ……*

D5. Do you have a television? *0. No; 1. Yes*

		Formal credit *(e.g. bank; government)*	**Informal credit** *(e.g. trader; relative)*
D6.	Did you receive any credit last year?	*1. Yes; 0. No*	*1. Yes; 0. No*
If yes:	D7. From whom? D8. Purpose? (*1. Crop expenses 2.Other ……)* D9. Amount & conditions/rate	…… *1. 2. ……* *Amount:……..* *Rate:…….. Length: ……*	…… *1. 2. ……* *Amount:……* *Rate:…….. Length: ……*
If no:	D10. Why not? *(tick)* *0. No need; 1.Too expensive; 2.Not available locally; 3.Difficult to obtain; 4. Other…..*	*0 1 2 3 4 ……*	*0 1 2 3 4 ……*

D11. Did your household provide any credit to others? *0. No; 1. Yes*
If yes:
D12. Amount: …… Rate …… Length period:……..

D13. Are you member of an agricultural organization? *0. No; 1. Yes, specify purpose*……..

D14. Where do you obtain agricultural information? *1. Radio; 2. Agric extension; 3. Other farmers; 4. NGO; 5 Other ……*

D15. When did you last have contact with an agricultural agent/extension worker? ……. Purpose:……..

		Fertiliser	**Herbicide**	**Traction**
D16.	Did your household ever use before?	*0. No; 1. Yes*	*0. No; 1. Yes*	*0. No; 1.Yes - Tractor 2. Yes - Animal traction*
If yes:	D17. When for the first time?	……	……	……
	D18. How did you obtain? (*1. Market 2. Government; 3. NGO; 4. Other…..)*	*1 2 3 4 ……*	*1 2 3 4 ……*	*1 2 3 4 ……*
	D19. Do you continue to use?	*1. Yes; 0. No*	*1. Yes; 0. No*	*1. Yes; 0. No*
If no use now	D20. Why does/did he not use (either now or before)? *(tick) 1.Too expensive; 2.Not available locally; 3.No money; 4. Other…..*	*1 2 3 4 ……*	*1 2 3 4 ……*	*1 2 3 4 ……*

E. Rice production

In case farmer is tired this is an opportune moment to break the interview. For subsequent sections use rice farmer as respondent. Rice farmer should be plot manager of selected rice field (preferably biggest rice field with sales of produce) – verify Table C1. If rice farmer is not the same as household head ask following questions. If the same, go to E7.

E1. Name (rice farmer): …… E2. Age (rice farmer): ……

E3. Sex (rice farmer): *1. Male 2. Female* E4. Relationship rice farmer - household head: *2. Child; 3. Spouse; 4. Other……*

E5. Can rice farmer read? *0. No 1. Yes* *Specify: 1. Arabic 2. English*

E6. Up to what level did rice farmer attend school?:
0. None; 1. Koranic; 2. Pre-primary; 3. Primary; 4. pre-secondary; 5. Secondary; 6. Tertiary or higher

E7. For how many years have you produced rice? ……

E8. Why did you start producing rice? ……

E9. Since then, did you ever stop producing rice? *0. No; 1. Yes, because* ……
……

E10. Which rice varieties do you use?

Name variety *(real or local name)*	Traditional or improved	Up- or lowland	Special distinguishing features			Year of initial use	Original source
			Grain	*Growing period*	*Other*		
……	*Trad / Imp*	U / L	……	……	……	……	……
……	*Trad / Imp*	U / L	……	……	……	……	……
……	*Trad / Imp*	U / L	……	……	……	……	……

E11. Which rice varieties have you abandoned? *0. None;*

Name variety *(real or local name)*	Traditional or improved	Up- or lowland	Special distinguishing features			Year of last use	Why abandon
			Grain	*Growing period*	*Other*		
……	*Trad / Imp*	*U / L*	……	……	……	……	……
……	*Trad / Imp*	*U / L*	……	……	……	……	……
……	*Trad / Imp*	*U / L*	……	……	……	……	……

E12. What are your main rice production problems?

1. ……
2. ……
3. ……
4. ……
5. ……

E13. Which constraint is most severe?

……

F. Rice field characteristics & management

For this section all questions focus on a selected rice field in the 2001 main season. Preferably select biggest rice field with sales of produce for this purpose - see Table C1. If no sales from any field take largest field. It is advisable to now go to the selected field with the farmer and complete interview there. This field will be measured at the end of the interview.

Plot number from Table C1: …….. *Rice area in 2001 main season: ……..*

F1. Is the field lowland or upland? *1. Upland; 2. Lowland; 3. Other ……*

If lowland

F2. Type of lowland:
1. Floodplain (> 200 m wide, drains into river); *3. Depression (closed area that does not directly drain into stream)*
2. Valley bottom (< 200 m wide, drains into stream); *4. Other ……*

F3. For how long does the field retain water after rains have stopped? …….. months

F4. Is the field waterlogged/swamp? *(i.e. badly drained and wet)* *0. No; 1. During rain season; 2. Always*

F5. Is the field subject to flooding? *(i.e. temporal submersion)* *0. No; 1. Yes*

If yes

F6. Intensity of flooding: *Depth ……. m* *Duration ……*
F7. Frequency of flooding: *1. Not every year; 2. Once every year; 3. Several times per year (# ……)*

F8. Is the field irrigated? *0. No; 1. Yes*

If yes

F9. Type of water source for the field?: *1. Surface/gravity irrigation; 2. Other ……..*
F10. Can you drain and irrigate the field when you like? *0. No; 1. Yes*
F11. What are the water charges you paid for this field per season last year? ……..
F12. What other water related costs did you pay for this field? *(eg costs pumping; labor cost maintenance)*. Specify type & cost:……

F13. Has the field been physically developed in any way? *0. No; 1. Leveled; 2. Bunded; 3. Other …*

F14. Does the field have stones? *0. No; 1. Yes*

F15. Is the field sloping? *0. No; 1. Slight slope; 2. Steep slope*

F16. Are there trees present in the field? *0. No; 1. Standing (# ……); 2. Felled (# ……)*

F17. What is the distance between the selected field and your house: …… km

F18. When was the field last fallowed? …….. For how long was it fallowed? …… years

F19. Please specify the cropping history of the field over the last three years:

	19 99		20 00		20 01	
	Main season	Minor season	Main season	Minor season	Main season	Minor season
Crops						
Mode of establishment [*]						
Use of chemical fertilizer	0. No; 1. Yes	0. No; 1. Yes	0. No; 1. Yes	0. No; 1. Yes	0. No; 1. Yes	0. No; 1. Yes

** Indicate special land preparation structures or activities (e.g. making heaps; ridges).*

F20. Rice Main season 2001

			Non paid labor			Paid labor							Input/output/service					
Operation	**Method used** (*specify*)	**Approx Date/ time**	**# Man [*]**	**# Days [*]**	**Total # MD [*]**	**# Man [*]**	**# Days [*]**	**Total # MD [*]**	**Unit**	**Unit cost**	**Total cost**	**# meal /day**	**Precise type** *(specify)*	**Source**	**Quan- tity Unit**	**Unit cost**	**Total cost**	**Observation**
Land Preparation														O/M/F/..				
														O/M/F/..				
Nursery	Establish & mgt Pot. area served: …..													O/M/F/..				
														O/M/F/..				
Establish - rice	Drill/Broadcast /Transplant												Rice seed ……	O/M/F/..				
- intercrop	Area:												Intercr seed ……..	O/M/F/..				
Weeding 1st														O/M/F/..				
2nd														O/M/F/..				
3rd														O/M/F/..				
Fertilizer 1st														O/M/F/..				
2nd														O/M/F/..				
Bird control														O/M/F/..				
Other pest ctrl														O/M/F/..				
Other mgt														O/M/F/..				
Harvest rice	Sickle/Knife/..												**Paddy**	**output**				
intercrop													**Other**	**output**				
Thresh&winnow														O/M/F/..				
														O/M/F/..				
Other ….																		
Other ….																		
	Explicit method (eg hoe ridging). Describe operations in more detail as needed	Calendar month or days after planting	Number of people (family & exchange labor)	By days worked. Indicate other unit as needed (eg hr)	Total mandays for family & exchange labor	Number of paid laborers	By days worked	Total mandays paid labor	MD: manday T: task.				Include name input (eg NPK; Gramoxone) or service (eg tractor harrow)	O: Own M: Market F: Farmer (other)	Indicate unit & conversion factor	Incl. purchase & transport cost		E.g. mention quality, timing & gender aspects – if any.

[*] Important column is total MD. People by days is meant as aid to arrive at total MD. If farmer can provide total MD for paid and non-paid labor breakdown over people & days is not needed.

In case 2nd rice crop fill following table. Otherwise skip to next page.

F21. Rice MINOR season 2001

			Non paid labor			Paid labor							Input/output/service					
Operation	**Method used** (*specify*)	**Approx Date/ time**	**# Man [*]**	**# Days [*]**	**Total # MD [*]**	**# Man [*]**	**# Days [*]**	**Total # MD [*]**	**Unit**	**Unit cost**	**Total cost**	**# meal /day**	**Precise type** *(specify)*	**Source**	**Quan- Unit tity**	**Unit cost**	**Total cost**	**Observation**
Land														O/M/F/..				
Preparation														O/M/F/..				
														O/M/F/..				
Nursery	Establish & mgt Pot. area served: …..													O/M/F/..				
Establish - rice	Drill/Broadcast /Transplant												Rice seed ……	O/M/F/..				
- intercrop	Area:												Intercr seed ……..	O/M/F/..				
Weeding 1st														O/M/F/..				
2nd														O/M/F/..				
3rd														O/M/F/..				
Fertilizer 1st														O/M/F/..				
2nd														O/M/F/..				
Bird control														O/M/F/..				
Other pest ctrl														O/M/F/..				
Other mgt														O/M/F/..				
Harvest rice	Sickle/Knife/..												**Paddy**	**output**				
intercrop													**Other**	**output**				
Thresh&winnow														O/M/F/..				
														O/M/F/..				
Other ….																		
	Explicit method (eg hoe ridging). Describe operations in more detail as needed	Calendar month or days after planting	Number of people (family & exchange labor)	By days worked. Indicate other unit as needed (eg hr)	Total mandays for family & exchange labor	Number of paid laborers	By days worked	Total mandays paid labor	MD: manday T: task.				Include name input (eg NPK; Gramoxone) or service (eg tractor harrow)	O: Own M: Market F: Farmer (other)	Indicate unit & conversion factor	Incl. purchase & transport cost		E.g. mention quality, timing & gender aspects – if any.

[*] Important column is total MD. People by days is meant as aid to arrive at total MD. If farmer can provide total MD for paid and non-paid labor breakdown over people & days is not needed

F22. From the same field and area, how much would you normally expect to harvest (ie. normal year) and what have been your highest and worst harvests? *(specify unit)*

	Normal (average)	Highest	Lowest
Main season	……..	……..	……..
Minor season	……..	……..	……..

If field or area planted is different from this year please indicate corresponding field and area.

F23. Which – if any - unusual events or management practices affected the yield in the field last year?……
……

G. Rice processing and marketing

G1. What was total paddy production last year (from all plots)? How was this total paddy production used?

Total production	Quantity already sold	Reserve for future sale	Quantity for consumption	Quantity saved seed	Other uses (spec)	Other uses (spec)

Before completing table, check reported total production with sum of rice plot production in C1 above.
Upon completing the table check and ensure that row total of right hand side corresponds with left hand side of table.

G2. Do you parboil your paddy? *0. No; 1 Yes*
If yes:
G3. Use of parboiled paddy: *1. Own consumption; 2. Sale; 3. Other……..*
G4. Where do you parboil your paddy? *1. At home; 2. Private parboiler; 3. Private mill; 4. Other …..*
If at home
G5. Number of parboiling drums/pots: ….. Capacity per drum/pot: …….
G6. Do you also parboil for others? *0. No; 1. Yes* What rate do you charge? …….
If elsewhere
G7. What rate do you pay? …… Other costs ……

G8. Do you mill your paddy? *0. No; 1. Yes*
If yes:
G9. Use of milled rice: *1. Own consumption; 2. Sale; 3. Other……..*
G10. How do you mill your paddy? *1. Manual/pounding; 2. Private mill; 3. Other …..*
If mill
G11. What rate do you pay? ……. Other costs ……

G12. Transactions of rice and paddy

	# trans-actions per yr	Transaction	Form	Quan-tity	Unit	Price per unit	When	Where	To/from who	Costs (*amount & type)*
Sale		Largest	1. 2. 3. 4.							
		2nd largest	1. 2. 3. 4.							
		3rd largest	1. 2. 3. 4.							
Gift given by household		Over 2001	1. 2. 3. 4.							
Purchase for consumption		Over 2001	1. 2. 3. 4.							
Gift received		Over 2001	1. 2. 3. 4.							
			1.Fresh paddy 2. Parb paddy 3. Rice local 4. Rice imported		Specify conversion factor as needed			F: Farm L: Local market M: Main market V: Village (own)	T: Trader M: Miller O: Other farmer s R: Retailer	*e.g. transport*

G13. Is the price received for paddy different for different varieties of paddy? *0. No; 1. Yes; 2. Do not know*

If yes

G14. Can you provide examples and the corresponding prices?

Variety	Price (spec unit)	Variety	Price

G15. Does the paddy variety you grow belong to the varieties that receive the highest price? *0. No; 1. Yes; 2. Do not know*

If no

G16. Why do you not grow the variety that receives the highest price?
1. Low yield; 2. Not adapted because……..……; 3. Seed not available; 4. Other ……

G17. For the same variety, is the price received different for different qualities of paddy? *0. No; 1. Yes; 2. Do not know*

If yes

G18. Which criteria determine the price? *1. Moisture content; 2. Foreign matter; 3. Appearance; 4. Other ……*

G19. Could you improve the quality of your paddy further so as to obtain a higher price? *0. No; 1. Yes; 2. Do not know*

If yes

G20. Why do you not improve the quality of your paddy? *1. Do not know how; 2. Time constraints;*
3. Cannot afford improved technology; 4. Not worth it (low price reward); 5. Other……

G21. Did you store your rice or paddy?: *0. No; 1. Yes*

Form *1 Fresh paddy; 2. Parb paddy 3. Rice*	Purpose *(1. Sale; 2. Consume; 3. Seed; 4….)*	Method used	Where	Quantity	Likely duration	Total costs *(amount & type)*
1. 2. 3.	1. 2. 3. 4……..					
1. 2. 3.	1. 2. 3. 4……..					

G22. What are your main rice marketing problems?

1. ……
2. ……
3. ……

G23. Which constraint is most severe?

……

H. Observations *(if any)*

……
……
……

I. Sketch of rice field and field observations & measurements

Length rice field: L1. …….. L2. …….. L3. …….. Width rice field: W1. …….. W2. …….. W3. …….. *(Indicate where measurements of length & width were taken. Provide more measurements as needed to allow estimation of size of irregularly shaped fields)*

Sketch field. Indicate land use adjacent to each side of the field (e.g. rice; yam; forest). Indicate presence of trees. Indicate area actually planted to rice & to intercrop if any

A. General

A1. Questionnaire number: V…… A2. State: ……

A3. LGA: …… A4. Village: ……

A5. Enumerator name: ……..…… A6. Reviewed by: ……..……

A7. Interview date: …/…/…… A8. Review date: …/…/……

A9. Informants names	Sex Profession
	M / F M / F
	M / F
	M / F

B. Village level infrastructure & resources

B1. What are the main economic activities for the village? *(indicate importance 1,2,3)*:
( ) Upland agriculture ( ) Commerce ( ) Other ……
( ) Lowland agriculture ( ) Craft industry ( ) Other ……
( ) Livestock ( ) Fisheries

	Main market	Secondary market	Nearest city
B2. What is the name of:			
B3. Distance from village (km)			
B4. Road type *(multiple response)*	*1. Tarred road* *2. Untarred all weather road* *3. Untarred dry season road*	*1. Tarred road* *2. Untarred all weather road* *3. Untarred dry season road*	*1. Tarred road* *2. Untarred all weather road* *3. Untarred dry season road*
B5. Road condition *(tick one)*	*1. Good condition* *2. Poor condition*	*1. Good condition* *2. Poor condition*	*1. Good condition* *2. Poor condition*

B6. What are the main ethnical groups in the village? *Main …… Minor ……*

B7. Does village have an official agricultural extension worker (e.g. ADP)? *0. No; 1. Yes, level…..*

B8. Does village have any agricultural project/NGO? *0. No; 1. Yes If yes: purpose…..*

B9. Does village have piped water? *0. No; 1. Yes*

B10. Does village have electricity? *0. No; 1. Yes*

B11. Is rice farming indigenous in the village? *0. No; 1. Yes*
If no:
B12. When did rice production start in the village? …… And rice consumption? ……

B13. Do rice growers have any distinguishable social features? *0. No 1. Yes, specify……*
(e.g based on sex; age group; ethnical group)

B14. What share of village households grow rice? …….

B15. Has total rice area in the village changed during the last ten years? *(tick one)*
0. No change; 1. Increased; 2. Decreased; 3. Other ……

If changed:

B16. Why did it change? ……
……..

B17. Did any of the villagers stop producing rice during the last ten years?
0. No; 1. Yes, because ……
……

B18. What have been major changes in rice *production practices* during the last ten years at the village level? ……
……

B19. Are men, women and/or children primarily responsible for the following rice production practices *(circle appropriate)*?

Practice	Gender	Observation (*if any)*
Land preparation	Men / Women / Children	
Crop establishment	Men / Women / Children	
Weeding	Men / Women / Children	
Fertilisation	Men / Women / Children	
Bird guarding	Men / Women / Children	
Other pest control	Men / Women / Children	
Harvest	Men / Women / Children	
Threshing & winnowing	Men / Women / Children	
Parboiling	Men / Women / Children	
Other ….	Men / Women / Children	

B20. What have been major changes in *rice consumption* at the village level?
……
……

B21. To whom do villagers normally sell their rice/paddy? *0. No-one; 1. Other villagers; 2. Local miller; 3. Local trader; 4. Traders from ……..; 5. Other …….*

B22. How many rice millers are operational within village? …… Of these, how many parboil?……

C. Procurement

	Hired labor	Other forms
C1. Can one obtain access to additional agricultural labor? C2. At what conditions/cost? *(eg wagerate)*	0. No; 1. Yes	0. No; 1. Yes, specify…….
C3. # of meals per day ?		

If labor includes provision of meal, estimated cost per meal: …….

	Lease	Other forms
C4. Can one obtain access to additional agricultural land?	0. No; 1. Yes	0. No; 1. Yes, specify…….
C5. At what conditions/cost? *(e.g. rent per season; spec unit)*		

	Formal	Other forms
C6. Can one obtain access to agricultural credit?	0. No; 1. Yes	0. No; 1. Yes, specify…….
C7. At what conditions/cost? *(e.g. interest rate & duration)*		

C8. For the village as a whole, please list availability of rice, inputs and services and corresponding location, prices and transport costs for purchase. (*In case of numerous agro-chemicals and/or services particularly ask for those that are used for rice).*

	Type/name	Availa-bility	Where *[tick main]*	Price	Unit	Transport cost per unit
Imported Rice	Parboiled	0. 1. 2. 3.	V / M / S / T			
	…….	0. 1. 2. 3.	V / M / S / T			
Local Rice/paddy	Paddy	0. 1. 2. 3.	V / M / S / T			
	Parboiled	0. 1. 2. 3.	V / M / S / T			
	…….	0. 1. 2. 3.	V / M / S / T			
Improved rice seed		0. 1. 2. 3.	V / M / S / T			
		0. 1. 2. 3.	V / M / S / T			
Traditional rice seed		0. 1. 2. 3.	V / M / S / T			
		0. 1. 2. 3.	V / M / S / T			
Fertiliser		0. 1. 2. 3.	V / M / S / T			
		0. 1. 2. 3.	V / M / S / T			
		0. 1. 2. 3.	V / M / S / T			
Herbicide		0. 1. 2. 3.	V / M / S / T			
		0. 1. 2. 3.	V / M / S / T			
Pesticide		0. 1. 2. 3.	V / M / S / T			
		0. 1. 2. 3.	V / M / S / T			
Tractor	Harrowing	0. 1. 2. 3.	V / M / S / T			
	…….	0. 1. 2. 3.	V / M / S / T			
	…….	0. 1. 2. 3.	V / M / S / T			
Processing	Parboiling	0. 1. 2. 3.	V / M / S / T			
	Milling	0. 1. 2. 3.	V / M / S / T			
	Other …….	0. 1. 2. 3.	V / M / S / T			
Other	Chemical spraying	0. 1. 2. 3.	V / M / S / T			
	…….	0. 1. 2. 3.	V / M / S / T			
	…….	0. 1. 2. 3.	V / M / S / T			
		0. No 1.Occassionaly 2. Seasonally 3. Always	Village Main market Sec. market Town		*If local, specify corresponding metric unit*	*If any*

C9. Is there some form of village level organization to:
- Buy inputs: *0. No; 1. Yes, specify…….*
- Sell produce: *0. No; 1. Yes, specify …….*
- Access services: *0. No; 1. Yes, specify …….*
- Other …….. *0. No; 1. Yes, specify …….*

D. Main crops by ecology and cropping calendar

D1. Please list rice and main crops by type of land and indicate crop calendar *(particularly indicate planting [P] and harvest [H] time)*

		Month																			
	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	…	…
Upland																					
Lowland																					
Irrigated																					